PRELIMINARY WORKING PLAN

OF THE

DEOBAN WORKING CIRCLE

FOR THE THREE YEARS FROM 1875-76 TO 1877-78,

WITH SPECIAL REFERENCE TO THE SUPPLY OF FUEL TO CHAKRATA

DRAWN UP WITH THE ASSISTANCE OF THE LOCAL FOREST OFFICERS,

BY

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SUGGESTIONS

CONCERNING THE FUEL SUPPLY TO CHAKRATA, INCLUDING PLAN FOR PLANTING UP THE WASTE LANDS IN CANTONMENTS, AND FOR WORKING THE FORESTS OF THE DEOBAN CIRCLE.

BY

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Inspector General of Forests to the Government of India

DATED SIMLA, 10TH JUNE 1875.

CONTENTS.

	PARA.
Introduction.	
Fuel for lime-burning	1
Fuel supplied to the Commissariat	2
Fuel supplied to the Station. Former arrangements	3
Present arrangements	4
Quantity of fuel supplied to Chakrata	5
Average annual requirements	6
Possible sources of supply	7
Land within cantonments	8
Fires and cattle must be excluded	9
The cultivation contract must gradually be abandoned	10
Operations already commenced	11
Future operations	12
Treatment of slopes facing the north	13
Treatment of tops and southerly faces of the spurs	14
Thinning out of old trees	15
Operations how to be supervised	16
Forests south of Chakrata	17
Deoban forests. Cost of delivery of fuel	18
Extent of Deoban working circle	19
Description of blocks. Matkangra	20
Darna	21
Jádi	22
Mohna	23
Kanjatra	24
Thona	25
Kutniar	26
Asmari	27
Kopli	28
Durani and Bajamara	29
Hajawa	30
A regular plan of operations not possible at present	31
Character of the principal trees	32
General rules of treatment	33
System of successive cuttings	34
System of selection fellings	35
Reproduction of the forest how to be ensured	36
Planting and sowing	37
Order of cuttings	38
Preparatory work for framing a regular plan of operations	39
Topographical survey	40
Blocks and Compartments	41
Description of compartments	42
Estimate of growing stock and annual possible yield	43
Classification of trees	44
Record of growing stock	45
Mean reducing factor how determined	46
Solid contents of stacked wood how ascertained	47
Cubic contents of standing stock how determined	48
Conclusion	49

APPENDIX.

I.—Specimen of description and proposals for working of compartments
II.—Growth of Spruce in the Thona and Kanjatra blocks.
III.—Growth of Silver Fir in the Kanjatra block.
IV.—Growth of Karshu in the Kanjatra and Mohna blocks
V.—Growth of Karshu coppice in the Mohna block.

INTRODUCTION.

As the present report is necessarily full of professional detail, it may not be out of place briefly to state the main results by way of introduction.

Fuel is now sold in quantities of not less than 20 maunds at a time to residents and approved dealers in the bazar at the forest depôt on the limits of cantonments, at the rate of 4 maunds per rupee, and it is proposed to maintain this rate, though it may entail a small loss to the Forest Department. The rate at which fuel is sold to the Commissariat and the Public Works Department is higher, and is fixed periodically according to the cost of these operations, as it is not yet possible to determine an average rate.

The main sources for the permanent supply of fuel to Chakrata are the unoccupied lands within cantonments, estimated at 1,500 acres, at an elevation between 5,500 and 7,000 feet, and a portion of the Deoban forests at an elevation between 7,000 and 9,200 feet, estimated to cover 4,500 acres. This area

remains at the station throughout the year, and is liable to reduction whenever the troops are in the plains during winter. In addition to this, the Public Works Department will require considerable but varying quantities until the barracks and other buildings are completed. This demand being fluctuating and temporary, we cannot make provision for it in the regular working plan to be drawn up for the forest nearest Chakrata, and the greater part of it must be supplied from a greater distance by extraordinary cuttings in forests not drawn upon for the ordinary requirements of the station.

Average annual requirements

6. Unless provision has to be made for a second regiment, it will be sufficient to assume 1,00,000 maunds of fuel as the present average annual requirements of the station, of which 10,000 maunds should be Oak. It has hitherto been customary to cut all fuel into 2-feet lengths, and experience has shown that 100 maunds of dry wood correspond to 240 cubic feet of stacked wood of Oak, and to 320 cubic feet of Fir. As the weight of a certain quantity of wood fluctuates between wide limits according to the greater or less proportion of moisture it contains, it will in some cases be more convenient to use 100 cubic feet of stacked wood (fuel cut into 2-feet lengths) as the unit of measurement. Eventually, we must adopt 100 cubic feet of solid wood as the unit of measurement throughout, but before this can be done, it will be necessary to determine the proportion between solid and stacked wood of different descriptions. The ordinary annual requirements of Chakrata may be expressed as follows:—

Oak wood,	24,000	cubic feet stacked	= 10,000	maunds
Pine wood,	2,88,000	„ „	= 90,000	„
Total	3,12,000	„ „	= 1,00,000	„

of dry wood. Nothing certain is as yet known regarding the yield per acre in these hills at an elevation between 5,500 and 9,000 feet; but considering the steep, and in most places precipitous nature of the ground, and what is known regarding the rate of growth of the principal trees, we are not justified in anticipating a higher annual yield than from 10 to 50 maunds per acre in well and completely stocked forests protected against cattle and fire, the larger yield being attained at lower elevations and on gentle slopes. A permanent supply of the quantity named would, therefore, require an area of completely stocked forest in extent between 2,000 and 10,000 acres, or say, 6,000 acres on different slopes and elevations, free of all grazing rights, and so situated that it can with certainty be protected from fire.

Possible sources of supply.

7. Leaving out of consideration small patches of village forest near the station, there are three great sources from which the requirements of Chakrata might be supplied:

First.—The waste lands within cantonment limits.

Second.—The forests south of Chakrata, *viz.*, the forests near Kalsi and the Bairat forest, between Pokri and Nagtat.

Third.—The forests north of Chakrata, a portion of which we propose designating as the Deoban working circle.

Land within cantonments.

8. The total area included within cantonment limits is, I understand, upwards of 3,880 acres, one half of which is either occupied by, or assigned for, building sites. Making allowance for roads and precipitous slopes, we may assume that at the outside 1,500 acres of waste and forest land are available for planting. A small portion of the available space consists of the slopes in the vicinity of the main ridge, principally along the main roads; but the main portion consists of the lower part of the spurs, which run from the main ridge to the headwaters of the Kutno river on the east, and to the feeders of the Amlawa on the west side. The highest point of Chakrata is, I understand, 7,400 feet, and the outer boundary probably descends 2,000 feet lower, so that the main space available for planting is between 5,500 and 7,000 feet. The spurs on the west side of the main ridge are generally more abrupt and bare than those on the east side, and in both cases there is a marked difference between the slopes facing the north, which are moist and fairly wooded, and the slopes facing the south, which are dry and bare. The rock throughout is clay slate, bare on steep slopes, but on terraces and gentle slopes covered with a deep layer of stiff yellow loam, the surface stratum of which is mixed in many places with much black vegetable mould. Limestone is only found in a few places. Springs are numerous and plentiful, and the subsoil is moist on many slopes at the driest time

of the year. In 1863, several years before the cantonment was established, I visited the place and found the ridge and the north face of the spurs stocked with an open park-like forest of Bán, Burás and Ayár. Along the ridge a good many trees have since been cut down to make room for roads and building sites, but the open forest on the north face of many of the spurs seems to me to be much in the same condition as it was 12 years ago. These patches of forest, however, cannot be touched to supply fuel to the station, unless systematic planting operations are first set on foot to replace the old stock. Within cantonment limits, therefore, the first question is, how to clothe the bare slopes and to raise a crop of young trees on the slopes which are partially wooded. Besides the three kinds mentioned, there is much Lodh (*Symplocos cratægoides*), two Willows, one of which (with grey leaves) grows on dry slopes. There is also *Ilex dipyrena* and a *Viburnum* (*V. nervosum*), but no coniferous tree is indigenous within cantonment limits, with the exception of a few Chīr (*P. longifolia*) trees near the lower edge.

Fires and cattle must be excluded.

9. The two first and essential conditions which must be fulfilled before planting on a large scale can be undertaken with any certain prospect of success, are the exclusion of fires and cattle. Fires have already partially been excluded during the autumn of 1874, and entirely up to April during the present spring. To make the exclusion of fire a certainty, it will be necessary to clear and maintain a path along the boundary line, outside of which a protection belt must be burnt once a year in the autumn. On precipitous ground the path cannot, of course, closely follow the boundary line, but a cleared path all round cantonments is essential, and it must be made accessible by numerous cross-paths joining it on to the main ridge. These cross-paths will, at the same time, serve to make all portions of the estate accessible, they will facilitate the carriage up to the station of wood and other forest produce, and they must be laid out with these objects in view. It will also be necessary to entertain a number of fire-watchers, and an attempt might be made to employ influential men of the neighbouring villages who, for an annual payment, may be willing to undertake the responsibility, each for a portion of the boundary line. The total length of the boundary line is about 27 miles, and it must be watched from the 1st November until 15th June, with the exception of one or two months during winter. An annual outlay of Rs. 250 must be estimated on this account. The right to pasture and cut grass within cantonment limits is now let for about Rs. 1,000 annually. The cattle belonging to the cantonment, that pay fees to the grazing contractor, are, I understand, estimated under 300 bullocks and mules, and 150 sheep; but it is probable that some of the cattle of the neighbouring villages also pay fees to him for permission to graze within cantonment limits. Government has the right entirely to prohibit grazing in cantonments, and there is no reason why cut grass and such grazing as may be available outside should not suffice for the cattle which now graze within the boundary line. The contractor cannot, however, be expected to give the same rent for permission to cut grass which he now pays for the whole grazing contract, and the income which must be sacrificed to attain this object is, I understand, estimated at Rs. 400 annually.

The cultivation contract must gradually be abandoned.

10. There is another item of revenue which will eventually have to be given up when planting is extended over the whole available area; this is the amount paid for the contract to cultivate up to one-third of the cantonment waste lands. I am informed that the contractor pays Rs. 2,000 for five years, so that this will involve the giving up of Rs. 400 per annum. The potatoe fields broken up by the contractor, include some of the best soil and most suitable places for planting, and the maintenance of this contract is incompatible with the extension of systematic planting operations over the whole of the cantonments. It may perhaps be considered expedient not to plant up the whole of the unoccupied land, nor is there any risk of this being done, for the precipitous slopes which cannot by any means be planted occupy a large portion of the area.

Operations already commenced.

11. What has hitherto been done has been to plant out in the vicinity of the ridge and on one easterly spur, a large number of plants brought from the forest. The Himalayan Horse Chestnut, the Walnut and the Hill Tún, have succeeded remarkably well even on bare and exposed slopes. Deodar and the Himalayan Spruce have failed everywhere except in gardens and in moist

sheltered places. Two nurseries have also been established, one in the public gardens under the ridge, and the other on a piece of flat ground on the slaughter-house spur. The higher nursery, which is sheltered, should be mainly used for Deodar, Kail, and Spruce, while the lower one is admirably suited for Horse Chestnut, Walnut, Hill Tún, Moru, Bán and Poplar. Below the Tún plantation on the spur first mentioned, Bán has been sown in lines, the seed close together, the lines 12 feet apart. The seed was collected in December and January, and sown in February. If the rains are early this year, these lines may succeed, but generally I would deprecate the sowing of acorns on bare slopes at this elevation.

Future operations.

12. The success of future planting operations will, as already explained, depend upon the exclusion of cattle and fires; but in addition to this it is necessary that they should be regulated by a definite plan, and limited during one season to a definite area; say, one spur at a time being taken in hand, and no extension attempted until it is completely stocked. The kind of trees most likely to give satisfactory results, and the mode of procedure, must be determined by actual experience, but for the commencement the following suggestions may be found useful.

Treatment of slopes facing the north.

13. The north face of nearly all spurs is irregularly and incompletely stocked with an open forest of the trees already mentioned. Under their shelter I would endeavour to raise Deodar wherever practicable, and this can probably be effected by planting and sowing in horizontal lines, the lines being from 15 to 30 feet apart, according to the nature of the ground, and being interrupted wherever there are trees or brushwood in the way. In the lines to be sown I would suggest that seed patches of about 18 inches in diameter be dug up in suitable places, and from 3 to 6 feet apart. The seed should be sown late in autumn, 6 to 10 picked seeds in each patch; the plants should be raised in a central nursery in seed-beds, 3 feet wide, consisting of a layer of sifted earth, 6 to 9 inches deep, on a hard surface; the seeds to be sown in regular lines across the beds, and to be bedded out early in the rains into other beds, from which they should be moved into suitable sites in the forest. Regarding the season of planting out, further experience must be gained; it is probable that at the elevation of Chakrata, the late autumn or the early part of the winter will be found to be the most suitable time, but both spring and autumn planting should be tried. I would suggest alternate lines of sown and planted Deodar on these slopes. In this manner it is hoped that a mixed forest of Oak and Deodar may be produced, similar in character to the mixed forest (the result of the natural spread of Deodar among Bán), which may be seen on the western face of Jako and on other slopes at Simla.

Treatment of the tops and southerly faces of the spurs.

14. Most of the plantable spurs have more or less flat ground on the ridge, which is generally bare. This, as well as the southern slopes, may be treated in different ways according to elevation. The lower half, I would suggest, should be planted up with a mixture of "Chīr" and a variety of leaf-bearing trees which will be mentioned further on. On the upper half, by way of experiment, a mixture of Kail (*Pinus excelsa*) and leaf-bearing trees may be tried. I saw a few specimens of "Kail" in a garden at the station. These, though apparently vigorous with long shoots, had commenced to seed prematurely, which is not an indication of good health. This, however, may have been accidental. "Kail," though apparently not in its element on the limestone rocks of Deoban and Thona, is generally found to thrive on soil similar to that of Chakrata, and its value as a tree that will grow on the barest slopes is so great, that it should certainly be used here, even if it were only to serve as a nurse for other trees likely to attain a greater age. It is just possible that the climate of Chakrata may be against it; if so, it must be cut out early after having done its duty as a nurse. The leaf-bearing trees which I would recommend to be grown in company with *Pinus excelsa* and *longifolia* are the following:—(*a*) At lower elevations Karīk (*Celtis australis*); Mulberry, Kīmu (*Morus serrata*, the kind cultivated near villages); Hill Tún, Dauli (*Cedrela serrata*). (*b*) On the higher slopes, the Himalayan Elm, Imri (*Ulmus Wallichiana*); Horse Chestnut (*Pavia Indica*) near ravines and in moist places. Three kinds of Maple, Kainzu *Acer pictum* and *caudatum*—(small trees) and high up near the ridge only *Acer caesium* (a large tree, leaves grey beneath). At all elevations I would plant the Walnut, the Himalayan Poplar, Choron (*Populus ciliata*), the grey Willow of Chakrata, and the Himalayan Alder, Udish (*Alnus nepalensis*); and I would every year sow a

quantity of the seed of the "Ayār" (*Andromeda ovalifolia*), which stands any amount of light and sun. Nearly all the trees here recommended to be mixed with Chir and Kail are known to coppice well, and where the slopes are not too steep, coppice with standards may at this elevation eventually be found the best for the production of fuel. But it would be premature to say more at present; what is required in the first instance is to clothe these slopes as rapidly as possible with dense Forest growth. When that has been accomplished, all further steps are easy. In the preceding list none of the Oaks have been included, and I would encourage their cultivation only to a limited extent, as, with the exception of "Ināi" (*Quercus annulata*) they are slow growers and coppice badly. Ināi could only be grown near the lower edge of cantonments in moist ravines, and by way of experiment, acorns of this handsome and shady tree may be dibbled in the lines. Bān *(Quercus incana)* and Moru *(Q. dilatata)* will be found to succeed at all elevations within the limits, and I would recommend that after some cover has been raised on the slopes in question, strong several-year old plants, raised in nurseries and bedded out with cutting back of the tap root and pruning, be planted out in horizontal lines. Karshu is not likely to thrive except near the top of the ridge. If plants of the Sweet Chestnut (*Castanea vesca*) can be obtained, they should be tried in gardens in the first instance.

Thinning out of old trees.

15. As soon as systematic planting has been set on foot in cantonments, it will be possible, and even desirable, to thin out old trees standing in groups or masses which are not required to shelter the young growth, and as soon as in any place the young growth is sufficiently advanced, a second and heavier thinning may be made. This is a right and legitimate mode of utilising part of the old crop standing on the ground, and these thinnings will make it possible to supply the station with a portion of the fuel required by it at low rates.

Operations how to be supervised.

16. A few words must now be said regarding the supervision required to carry out these operations with a reasonable chance of success. I am inclined to think that the zeal of the members of the Cantonment Committee, and the special interest which Commanding Officers will, as a rule, take in these operations, may not always prove sufficient to ensure success, for the simple reason, that the Commanding Officer and most of the members of the Cantonment Committee frequently change, and may not always possess the needful knowledge of arboriculture. In case the military authorities should really desire to utilize the spare land within cantonments for the production of fuel, the best plan would probably be to make the Forest Officer in charge of the Deoban Circle responsible for the plantations within cantonments. Much of the planting in Chakrata can be done late in autumn or early in spring, when the Deoban forests are closed by snow, and the experience which this officer would gain in planting work in his own forests would serve to promote the success of the operations in cantonments. In all questions affecting the cantonment interests, the Forest Officer would be subordinate to the military authorities, while in all professional matters he would be responsible to the Conservator. From these remarks it will be apparent that if these suggestions are accepted, a small portion of the fuel requirements can, a few years hence, be met by thinnings within cantonment limits, and that eventually, when the 1,500 acres of plantable land are fully stocked, they may yield upwards of 30,000 maunds of fuel per annum, and perhaps even more. This, however, will not be within our time, and so we must now consider the second source.

Forests south of Chakrata.

17. Of the forests south of Chakrata, two tracts only require notice,—the Kalsi and the Bairát forests. In the vicinity of Kalsi there are several hundred acres of second class forests, but these are mostly on precipitous ground, and could only be worked sparingly; there is, however, in the Dún the Government forest of Ambari and a large extent of private forest. The fuel from these sources could be carted up by the cart road; but I am informed that at the present rates for cutting and carriage, the fuel from this source would cost Rs. 75 per 100 maunds, which, of course, is prohibitory. The Bairát forests cover the northerly slope of the range between Nagtat and Pokri. They are imperfectly stocked with Bān and the trees that ordinarily accompany it, and may be estimated to contain 1,500 acres, of which about 370 acres in two blocks are second class, the rest being village forest. In their present condition no supplies of any importance can be expected from this source. In the second class forests Government has not the right to exclude grazing; but if it were possible by any means to acquire complete control over the whole of these

forests and the intervening blank slopes, the supply of another 30,000 maunds annually might eventually be secured at low rates from this source; the average distance of the forest from the edge of cantonment is 8 miles, but by a level road, along which a tramway might easily be made. It would, however, not be expedient to disturb existing arrangements with regard to these forests, for they are resorted to by the inhabitants of all the surrounding Khutts for wood and pasture, and these could not easily be provided elsewhere.

Deoban forests; cost of delivery of fuel.

18. Under these circumstances, it is evident that the Deoban forests must be regarded as the principal source of the supply of fuel for the station; and the first question is, what is the present cost of delivering fuel from that source? According to information received from Mr. Bagshawe, the rates at present paid for cutting, collecting and carrying 100 cubic feet of stacked wood are about as follows:—For Fir fuel cutting and collecting in forest Re. 1-9, carriage Re. 1-0-8 per mile. For Oak fuel cutting and collecting in forest Rs. 2-1-4, carriage Re. 1-6 per mile. Roughly speaking, this amounts to Rs. 5 per 100 maunds of either Fir or Oak fuel for cutting, collecting and stacking, and Rs. 3-5 per mile for carrying the same quantity. These figures will explain that the cost of 100 maunds of fuel carried 8 miles is Rs. 31-8. This leaves no margin for contingent charges, supervision, loss and wastage. Provision for these items will raise the cost at least to Rs. 35 per 100 maunds; but I am informed that no data are as yet available to make an exact calculation of the cost. A tramway and fuel-slide could only be constructed to serve part of the forest, and would in itself be an expensive undertaking, so that fuel will always have to be carried a considerable distance on the backs of animals. The difficulty in constructing slides and tramways consists not only in the extremely precipitous, rocky and broken nature of the ground, but equally so in the fact that the total value of the annual deliveries amounts, even at Rs. 35 per 100 maunds, to Rs. 35,000 only.

Extent of Deoban working circle

19. These figures will show that a distance of more than 8 miles from the depôt may, under existing circumstances, be regarded as prohibitory. We have therefore decided at present to include within the Deoban working circle those forests only which are situated within that distance of Chakrata. It must not, however, from this be inferred that these forests will suffice to supply the fuel requirements of Chakrata. The exact area stocked with forest cannot be known until a detailed topographical survey has been made, but so much is certain, that it is under 5,000 acres, and that sheep and goats are at present excluded only from a few hundred acres. The annual permanent yield of this area will entirely depend on the question what portion of it can be closed against pasture, and until that question is settled, it would be premature to say whether the forests within the 8 miles radius will suffice for the permanent supply of Chakrata. The forests provisionally included within the Deoban circle we have agreed to divide into twelve blocks, each of which is defined by natural geographical boundaries, and recognised by a local name. The situation and approximate boundaries of these blocks are shown in the sketch map annexed, which also indicates those portions that are stocked with Oak and those with coniferous trees.

Description of blocks—Matkangra

20. Under the circumstances here explained, it will be best to agree upon a provisional working plan for these twelve blocks during the next three years only, *viz.*, from 1875-76 to 1877-78. Before, however, proceeding to sketch the order and system of cutting and regeneration, and the treatment of these blocks generally, it will be necessary briefly to indicate the character of each. The block nearest Chakrata is "Matkangra." It consists of a succession of steep and mostly bare bays and ravines forming the head of the Amlawa valley, with rocky and precipitous sides, the rock being limestone, here and there stocked with "Bán" and "Moru." Owing to its vicinity to Chakrata there have been heavy cuttings, and except thinnings on some of the northern slopes after regular planting shall have commenced, no wood can at present be taken from it. This block may provisionally be divided into five compartments as follows:—

I. Karbin, Forest boundary to Limekiln spur.—This is the best portion of the entire block, and if cattle could be excluded, which may be difficult on account of the vicinity of the cantonments, it should be taken in hand at once. Both sides of the Karbin spur have an average gradient of less than 40°, and are fairly stocked with Bán and Moru. They should be planted up with Deodar if

sheep and goats can be kept out, and the ground near the Amlawa stream should be examined for a nursery site.

II.—*Bajri quarry*, continuation of compartment I to the southern plantation spur.

III.—*Plantation*, comprising the wide bay between the southern and northern plantation spur.

IV.—*Amlawa head*, from northern plantation spur to Bangárdhár, comprising the head of the Amlawa valley.

These two compartments, III and IV, should at once be protected against cattle and be planted up. This is supposed to be feasible, as this part of the block is farthest away from cantonments and from the Bangár village. The ground is rocky, much of it is precipitous, and must be classed as unimprovable and unproductive ground. Those portions which can be planted, I would suggest should be treated as follows: The slopes with a north-west aspect, and the bottom of the ravines, as far as they are fairly stocked with Oak and other trees, should be sown and planted with Deodar in lines 15 feet apart, plants and seed patches being placed at suitable spots at a distance within the lines of between three and six feet. The lines will, as a matter of course, be interrupted where the ground is rocky and precipitous, or where trees and shrubs are in the way. The result aimed at is a mixed forest of Deodar and leaf-bearing trees, similar to that which it is suggested should be produced on similar slopes in cantonments. A crop of self-sown young Oak, to grow up with the Deodar, will probably spring up as cattle are excluded and the ground is broken up by these operations. In moist places the Horse Chestnut should be planted in place of the Deodar. A nursery of Moru, which was established at the bottom of the valley in compartment III in 1873, is well stocked with plants, which require to be bedded out after pruning them and cutting back the tap root. A quantity of plants has already been sent from here to the cantonment nursery, and the rest may either be used in cantonments, or employed to stock the slopes which have a south-east aspect and are not precipitous; in these compartments strong plants, several years old, which have been bedded out once or twice, should be employed for this purpose. There is not, however, much chance of this succeeding on a perfectly bare slope, and the question of the nurses to be employed must be considered. *Pinus excelsa* is, as far as our experience goes, unsuitable for limestone, and therefore the only coniferous tree likely to thrive at this place is the Cypress (*Cupressus torulosa*), which is partial to limestone. It clothes part of the Lokandi peak, and several trees are found in the upper part of compartment IV. This tree is not difficult to raise, but no experience on a large scale has yet been gained. A Cypress nursery should be established in this block, and an attempt made to plant it out on slopes having a south-east aspect. If strong plants are used, the Cypress will probably succeed even on bare slopes, and can afterwards be interplanted with Moru. Sowings of Cypress *in situ* I do not recommend at present. The Himalayan Poplar, the grey Willow, and Ayar may also be used as nurses. All plantings and sowings should be made in horizontal lines as previously suggested.

V.—*Bangár*. From Bangárdhár to forest boundary. The upper part is very precipitous; the lower part below the new Simla road consists of broken ground with easier slopes, which might be planted up; but it will probably not be desirable to close this portion of the block against the sheep and goats belonging to the Bangár village. Soil and the gradient of slopes in Mátkángra are not promising, but part of it is at a low elevation, and, therefore, favourable for planting. Being close to cantonments, the utmost must be made of it, and on that account we have agreed to concentrate in it, for the present, all planting operations of Deodar and Moru in the Deoban Circle.

21. Adjoining Mátkángra on the north-west is the *Darna* block, which occupies the south side of the Amtiyar valley down to the forest boundary. It is similar in character to Mátkángra, but with more gentle slopes in its south-east corner, which should eventually, if possible, be converted into first class forest. This block also was heavily felled for lime and charcoal up to 1870, and it is at present very incompletely and unevenly stocked with Bán and Moru, with extensive blanks between. No cuttings are contemplated in the Darna block during the next three years. Darna.

Jádi.

22. The *Jádi* block adjoins Mátkángra and Darna, and occupies the head of the Amtiyár valley. Excepting the lower parts near the village of Jádi and Mangár, and the parts adjacent to the Deoban bungalow (towards Kanjátra Lani), it is rocky and precipitous. The upper part near the main ridge is stocked with Karshu, mixed in places with Spruce and Silver Fir; below this there was formerly a compact belt of dense Spruce forest, in which extensive fellings took place in 1868-69 for the erection of the first temporary buildings in the station. It is remarkable that these fellings have hardly produced any young growth, although there is sufficient light in many places. This is particularly noticeable below the present road from Chakrata to Deoban. One reason assigned is, that a portion of the trees left standing were too young to seed freely. This, however, does not fully explain it, as many of the trees are above 6 feet in girth; nor can it be said that the felling has anywhere been excessive. Sheep and goats, the precipitous nature of the ground, and in places the heavy underwood of Ringall and Willows, which increased as light was admitted, may have contributed much to prevent reproduction; but whatever the cause may have been, this part of the block will require rest for many years, and, if possible, protection from sheep and goats. The upper part of the block, below the main ridge, consists of four distinct valleys or ravines, densely wooded, and with much young growth of Oak, Spruce and Silver Fir, and in this portion the cutting out of large trees overtopping the young growth is most desirable, and in places urgently necessary. Near the main road is a large extent of young Oak forest of poles and saplings, mostly coppice and pollard shoots, in which thinning is required. The necessity of thinning in this young Oak forest is illustrated by the extensive damage done by the heavy snow fall of February last. In order to ascertain the coppicing and pollarding power of Karshu at that age, half an acre of well and evenly stocked forest with a south aspect, about 20 feet high, and the stems between 3 and 6 inches in diameter (average of 27 stems 4·7 inches, wood only) were cut over in April last, the stumps left on one-half being 18 inches*, and on the other half 4 feet high. The outturn was 500 maunds; and making allowance for the high stumps left standing, 570 maunds. The average age of the trees was determined by the examination of 27 trees at 33 years, so that the average annual production per acre in this case was 1,140 : 33=34·5 maunds. This is not unfavorable for an elevation of 9,200 feet. These thinnings, and the cutting out of large trees, will furnish a considerable quantity of material during the next three years.

Mohna

23. *Mohna block.*—This comprises the whole eastern face of the Deoban range from near cantonment limits to Kaunti Lani. The southern part of it consists of precipitous and unequally stocked slopes, with very large blanks, but the main portion is better stocked and more promising than any other part of the Deoban Circle. The spurs which subdivide this block into compartments run more or less in an easterly direction, and the best and most compact forest occupies the slopes facing the north or north-east. Like the Jádi block, the upper part is stocked with Oak and mixed forest, and the lower part contains Spruce and Silver Fir, with a large proportion of Moru, together with Sycamore and the Horse Chestnut in the ravines. From the best stocked portions of this block, cattle, sheep and goats have been excluded since 1873, and the beneficial effects of this measure are manifest on all blanks and bare grassy slopes in the vicinity of the forest. Seedlings of Spruce and Oak are coming up in large numbers, and in addition to this most satisfactory natural reproduction, a considerable extent of blank slopes near Deothat has been sown by dibbling in Karshu, which has succeeded remarkably well. This was done in the rains of 1873 by Mr. Whittall, and the success of this operation is very creditable to that officer. In the stocked portions of this block, wherever there was room, is an abundance of vigorous young growth both of Oak and coniferous trees, of various ages, only waiting for more light to shoot up and take the place of the old crop; and the cutting out of the mature trees is in many places urgently required. In the Mohna block is also a quantity of young Oak forest similar to that described in Jádi, in which an experimental cutting of similar extent on a northerly slope was made a short time ago; the quantity, however, was not measured up, so that the average annual production per acre cannot be determined. The stems were taller, the average diameter (of wood only) and average age of 103 trees was found to be 4·8 inches and 34 years. The well-known mature and compact

* I understand that the shorter stumps have since been cut flush with the ground.

Karshu forest between Snow View and Deothat forms part of this block. The ground is here covered with seedlings, which, however, mostly die off for want of light. This tract it is not proposed to touch at present, but to keep as a reserve to meet future requirements of Oak fuel. A portion of this forest is described in the Appendix. In the same block, south-east of Deoban, is the ravine which at present feeds the Chakrata water channel, and between this ravine, commonly known as C Nala and Kantilani, are the ravines commonly known as A, A′, B, B′, which are intended to feed the projected new canal. The catchment basins of these ravines are well stocked, and it is essential that they should not be denuded. No clear felling by compartments therefore can on any account be permitted in this block; all cutting must be done by selection of single trees, or by careful thinning in mature forest in order to give light for the young growth to come up. These are the thinnings and cuttings which are contemplated in this block during the next three years. It is impossible to estimate what these cuttings will yield, but it is hoped that they will furnish one year's supply for the station. While these operations are progressing, the officer in charge will be able without loss of time to supervise the work at the Deothat Nursery, which should, therefore, be maintained for the present so as to have a large stock of strong plants ready by the time the wood has been removed from the forest. The aim should be to stock all blanks with a mixture of Spruce, Silver Fir and Deodar, mixed with Karshu above and Moru below, and Maple, Alder, and Horse Chestnut in suitable places

21. *Kanjátra.*—The Kanjátra block occupies the head of the Marauwagad, one of the feeders of the Benargad; on the east it extends to the main ridge, while on the south it is bounded by the Thona ridge. The upper part of this block comprises the remainder of the Oak forest which clothes the top of the Deoban hill in the Jádi, Mohna, and this block. The rest is Spruce forest with a small proportion of Silver Fir, and extensive blanks on the lower slopes. In this block heavy cuttings were made in 1869, 1870 and 1871. There is some young growth here and there, but much less than in the Mohna block. To a great extent this may be ascribed to sheep and goats, but not altogether, and it is probable that at this high elevation, the cold north side of the hill which Kanjátra occupies is less favorable for reproduction than the warm east side. Another difference is, that in Mohna the forest is largely mixed with Oak and other leaf-bearing trees, the leaf-fall of which enriches the soil and retains the moisture more than is the case in Spruce or Silver Fir forests. Before any further cuttings are made in Kanjátra, sheep and goats must be excluded, so as to see how far natural reproduction may be hoped for When Kanjátra comes to be divided into compartments, it will probably be best to use a number of dry ravines running down from the Thona ridge as division lines. Appended to this report will be found a descriptive account, with proposals for working five provisional compartments in Kanjátra. The proposals are made on the supposition that sheep and goats are excluded. If this can be accomplished, the cuttings in Kanjátra may furnish the supply required for 1876-77. Kanjatra

25. *Thona.*—The Thona block is a continuation of Kanjátra, and is similar in character; here also heavy fellings were made in 1869-70. Except on precipitous ground, the reproduction is worse than in Kanjátra. A description, with proposals for working the portion near the Bodya Deoban path, will be found appended to this report. In this block a Spruce nursery has been established on a very promising site, and was sown early this spring. A commencement has also been made to fill up the large extent of grassy slopes in the vicinity of the nursery, by carefully prepared lines 12 feet apart sown with Spruce Fir. It will be necessary to enclose this blank, which is to be operated on, with a wire fence, as it will probably not for some time be possible to close the Thona block against grazing. Should it not be possible otherwise to provide for the requirements of the third year, endeavours must be made to exclude sheep and goats from that part of Thona which adjoins Kanjátra, so as to extend cuttings in that direction. Thona

26. The *Kutnaur* block occupies the broad undulating back of the Thona ridge, and extends some way down the south slope to the forest boundary. The old path from Deoban to Lokandi led through it, and the forest is noticed on page 65 of the Bussahir forest report of 1865, in which are recorded the valuation surveys made by me in Jaunsar in 1863. This is a narrow block, the upper part of which is well stocked with Karshu forest, with much young growth, and mixed in the lower part with Spruce and Silver Fir. Kutnaur

Asmari

27. The *Asmari* block is a continuation of the west of Thona, and consists of a series of deep bays with gently sloping sides, partially stocked with a mixture of Spruce and Deodar, and in the lower and more precipitous parts with Deodar and Moru, with a few Spruce. On account of the gentle slopes, and the large proportion of Deodar, this is a most valuable block, but it is the favourite grazing ground for cattle, sheep and goats from the adjacent villages. Soil and position are evidently favourable for the reproduction of Deodar, for, wherever it is protected from cattle by means of the dwarf *Cotoneaster* (Kurtia), young Deodar is coming up in abundance. The upper part of Asmari may most conveniently be divided into three compartments, which form three natural bays, separated by secondary ridges.

Kophti.

28. The *Kophti* block comprises the isolated Kophti hill, the upper part of which is clothed with Karshu, as well as the sides of the ridges which extend from it towards Koti as far as the Kanásar first class forest, and also the slopes on either side. The slopes towards Kanásar are gentle; those towards Asmari and Thona steep. The block unequally stocked with Spruce and Moru on the Thona side, and Spruce, Kail and Deodar on the north side. The western half is nearly blank. No operations are contemplated in this block until sheep and goats can be excluded.

Durani and Bajamara

29. The *Durani* and *Bajamara* blocks occupy the north face of the ridge, from the head of the Marauwagad to the end of the eight-mile radius towards Konain. Nearly the whole of these blocks is extremely precipitous. They are divided by rocky spurs into a succession of bays, of which the heads and the slopes facing the east are well stocked, and the western slopes bare. The forest consists of Karshu on the ridge, Deodar on the very precipitous ground, and mixed forest of Spruce and Silver Fir, Horse Chestnut and Sycamore on the more gentle slopes. In that corner of the Durani block which joins the head of the Kanjátra block below Kaunti Lani, heavy fellings of Spruce were made from 1869 to 1871 for building timber. There is no recent reproduction whatsoever, although there is no lack of seed-bearing trees, and in parts sufficient light, as well as plentiful soil on a moderate slope. This corner should, if possible, be closed against sheep and goats simultaneously with the Kanjátra block. The remainder of these two blocks, however, should be used to provide high grazing ground for those villages that will lose their high pastures when Kanjátra, Jádi, Kutniar, Thona, Asmari and Kophti are closed.

Hajawa

30. *Hajawa* is the last block on the south face of the main ridge, and is composed of two portions, which are separated by a prominent spur, known as the Hajawa dhar. The western portion consists of a series of precipitous valleys between the main ridge and the Hajawa spur. The upper part is stocked with Karshu, with underwood of Ringall, and young growth on all gentle slopes without reference to aspect. The sides of a triangular valley nearest the fuel slide are fairly clothed with a mixed forest of Spruce Oak and other leaf-bearing trees, but the rest is poorly stocked and unimprovable, and it is not proposed to attempt to exclude pasture from this part of the block. The eastern portion, however, is a most valuable, and in parts completely stocked Pine forest, clothing the north face of the Hajawa spur, and extending down to the bottom of the valley. At the head of the valley, near the main ridge, are extensive bare slopes, with scattered groups of Deodar. The compact forest may be estimated to cover an area of about 300 acres. Near the top it is mainly stocked with Silver Fir; lower down with a larger proportion of Spruce, which is mixed with Moru, Bán and Inái near the bottom of the valley. The average slope is about 30°, but it is steeper above and more gentle below. Beyond the fuel slide, along the path to the Baniani village, there is a considerable extent (500 yards long) of perfectly stocked forest, consisting of large poles, with a small proportion of trees 6 to 7 feet in girth, all very tall up to 150 feet high. Further on, the forest has been partly destroyed for pasture by girdling and burning, and the result is a succession of open glades, with groups of large and tall trees. At present there is no young growth, but this part of the forest would recover speedily if cattle were excluded. The whole forest is the favorite grazing ground of numerous villages further east, and everywhere there are open glades (táches), so that it seems doubtful whether it can ever be closed. Should it, however, be found possible to close and to take it in hand, it would probably be convenient to use the ravines as demarcation lines of compart-

ments. The only way in which this forest could be utilized for the fuel supply of Chakrata would be by the old fuel slide and the Mohna road, which were made for the export of dry wood. The upper part of the forest only, above and on a level with the head of the slide, has as yet been cleared of dry wood. Before work is commenced in the lower part, it should be considered whether a double slide or tramway might not be constructed, the longer branch leading down the slope into a lower belt of the forest, and the shorter but steeper branch down the present fuel slide, with two trucks running down abreast, one drawing the laden truck up the lower half of the longer branch, while the other draws it up the second half.

The present fuel slide is, I understand, about 300 yards long, and goes down a uniformly steep ravine with high sides. An estimate must be made of the quantity of dry wood available, and of green wood that will be furnished by the first cutting, and if it should be found that the quantity is sufficient to justify the construction of the double slide, and if arrangements can be made to close this block against sheep and goats, then the sooner the mature portion is worked the better, in order to prepare the way for a uniform crop of young forest.

A regular plan of operations not possible at present.

31. Having now sketched the prominent features of each block, it remains to discuss the plan of operations. The object is to furnish a specified annual quantity of fuel to Chakrata at the least possible expense, under arrangements which will secure the permanent supply of a similar or increasing quantity.

The preceding remarks will have explained that the area requisite to furnish this supply has not yet been determined, and that nearly the whole of the area at present available is burdened with rights of pasture, which will make it impossible to calculate upon it for any permanent supply. Under these circumstances it is evident that a regular plan of operations cannot be drawn up at present, and we must be satisfied with indicating the leading principles which should guide the working of these forests, and with suggesting the measures necessary to prepare the ground for a regular plan of operations. At the same time it will be necessary to suggest the plan of cuttings and other operations requisite during the next few years, and under the circumstances of the case it seems best to limit these suggestions to the next three years. The remarks on these subjects will be recorded under the following heads :—

(1.) Character and requirements of the principal trees.

(2.) General rules of treatment.

(3.) Reproduction how to be ensured.

(4.) Order of cuttings, and

(5.) Preparatory work for a regular plan of operations.

Character of the principal trees

32. The principal trees composing these forests which require notice here are, of conifers, the Himalayan Spruce, Silver Fir and Deodar, and of leaf-bearing trees, the three Oaks, Karshu, Moru and Bán. In addition to the present remarks, attention is requested to Mr. Ribbentrop's remarks on the character of these trees, recorded on page 28 of the Preliminary Working Plan of the Sutlej Working Circle, 1875.

(1.) *The Himalayan Spruce, Rai, Abies Smithiana.* The hanging cones ripen and the seed falls in October or November. The last heavy seed years were 1871 and 1871; there was scarcely any seed in 1873. It is believed that in the Deoban forests a full crop of seed generally occurs once in three or four years. Seedlings of the Himalayan Spruce spring up readily and grow up vigorously in open places without shelter in the Deoban forests, provided they are not too dry. Young plants up to 6 feet high are often found under the shade of large trees, but they do not generally look vigorous, and make no progress until sufficient light is given. On the other hand, where sheep and goats allow it to come up, young growth of all ages is found on the edge of the forests and on perfectly bare slopes. Under these circumstances it will be necessary, in forests mainly consisting of Spruce, to give much light when cuttings are made, with the view of ensuring the natural reproduction of this tree. This remark mainly relates to slopes with a more or less northerly aspect, at the mean elevation of the Thona and Kanjátra blocks. It is not impossible that in other forests on different rock, at a lower elevation, and in a different climate, this tree may require a different treatment.

The greater part of the Deoban forest is on limestone; on the granite and quartzose rocks of Kunawar and the Rupin valley, the Himalayan Spruce certainly stands a great deal of shade while young. The rate of growth in the Deoban forest is fairly good: a detailed statement of rings counted on 67 stumps in the Thona and Kanjátra blocks on slopes with a northerly, north-easterly and north-westerly aspect, and at an elevation of about 8500 ft., is given in Appendix 2. The result may be expressed as follows:—

Girth at 5 feet from the ground.	Corresponding radius (of wood only) on the surface of the stump.	Age in years.	
		Spruce.	Silver Fir.
1'6"	2·9"	25	25
3'	5·7"	55	50
4'6"	8·6"	90	81
6'	11·5"	125	113

Young Spruce is readily eaten by sheep and goats, and in many places we found this to be the cause of the stunted appearance of young trees. Old stems, like those of the European Spruce, are, under certain circumstances not yet explained, subject to dry rot in the centre. It is probable that plantations of this tree will succeed easily, and that it can with advantage be employed to stock open grassy slopes, particularly with a northerly aspect.

(2.) *The Himalayan Silver Fir, Morinda, Abies Webbiana.*—The erect cones break to pieces, and scales and seeds fall in October or the beginning of November. The last good seed year was in 1871; there was not much seed in 1873 or 1874. Like the European Silver Fir, young trees of the Morinda require shelter, and live for a long time under deep shade, maintaining a bright green color and a healthy appearance, but making little progress until light is given over head, when they produce vigorous terminal shoots. In the compartments specially examined and described in the Appendix, the Silver Fir is much less common than the Spruce, yet every where there was much more young growth of the Silver Fir on the ground than of the Spruce. Wherever natural reproduction on a regular system is attempted in these forests, success will probably be certain in the case of the Silver Fir, and on that account Morinda trees likely to shed seed should be spared in all cuttings as much as possible. Old stems are generally sound, and there is no ground to anticipate that the wood will be less acceptable as fuel than that of the Spruce. Regarding its rate of growth, we have as yet only the rings counted on the stumps of eight trees at a high elevation in Thona and Kanjátra, recorded in Appendix 3. The result is given above side by side with that of the Spruce.

(3.) *Deodar, Kelu, Cedrus Deodara,* forms a small proportion of the forests at intermediate and lower elevations of the Kanjátra, Asmari and Kophti blocks; it is more numerous, and in places is the principal tree, on rocky slopes with a south aspect, in the Bajamara and Hajawa blocks. In such places the tree reproduces naturally with great vigour, and it will not be difficult to increase its proportion where natural reproduction is principally relied upon. The seed ripens between the 15th October and 15th November; scales and seed fall together; 1872 was the last heavy seed year, but there was a moderate quantity in 1873 and 1874. Considering that Deodar scantling realizes Re. 1-8 per cubic foot at Chakrata, while 100 maunds of fuel, corresponding to about 200 cubic feet solid wood of Deodar* only realize Rs. 25 to 35, and that it is desirable to make every effort in order to deliver it at a lower rate, it certainly seems proper to encourage the spread of Deodar in those few compartments of the Deoban Forests where it has its natural habitat, excepting always those places whence timber cannot profitably be removed, though they may be worked for fuel. From what is known regarding the rate of growth of Deodar in Jaunsar, it may be supposed that at elevations under 7500 ft. and under ordinary circumstances, a girth of 6 feet is attained in 70, and of 4 feet 6 inches in 55 years.

(4.) *Pinus excelsa, Chil, Kail,* is scattered here and there, and nowhere very vigorous in the Deoban forests, excepting in the lower part of the Kophti

* 1,800 cubic feet of stacked Deodar in two-feet lengths weighed in the month of November 610 maunds. This wood had been cut the previous year.

block. It is for further enquiry whether this tree does not thrive on limestone, or whether climate or other circumstances are against it. On quartzose argillaceous or micaceous schists, or on gneiss and granite, the tree grows with great vigour and is extremely valuable, because it requires no shelter when young and springs up abundantly on bare slopes. Within the limits of cantonments I suggest that it be grown extensively as a nurse for other trees which require shelter, but on the limestone rocks of the Deoban forests I am not at present disposed to encourage its cultivation. The tree seeds freely every year, but 1873 was a particularly heavy seed year. The seed ripens at the end of September or in October.

(5.) *Karshu, Quercus semecarpifolia*, pure, or mixed with the Spruce and Silver Fir, often with underwood of Ringall. This tree clothes the top of the Deoban hill and the crest of the principal ridges. It is the principal tree of the Kutniar block; it forms compact masses in the upper part of the Kanjátra, Mohna, Jádi and Hajawa blocks, and is also found near the ridge in the Durani and Bajamara blocks. The most important masses of forest in which Karshu is the principal tree, are the following :

	Acres.
1.—Deoban hill in Mohna, Kanjátra, and Jádi blocks, about	330
2.—Kutniar block	180
3.—Kophti block	40
Total about ...	550

These forests have the great advantage of comparatively easy slopes and deep soil, mostly a stiff clay, more suitable for the growth of Oak than of Spruce, though the Silver Fir seems to thrive on it. They are also well stocked upon the whole; the drawback is the high elevation between 8,500 and 9,200 feet. There are no data regarding the annual production per acre of a Karshu forest, but considering the results of the cutting made in the Jádi block adverted to above, it does not seem unreasonable to expect a yield of 40 maunds per acre, part of which will be Pine wood. Making allowance for precipitous and unproductive slopes, an annual yield of 20,000 maunds may be expected from these blocks, of which about three-fourths would be Oak. This is on the supposition that cattle are excluded. It is evident that every exertion should be made to obtain complete control of these forest tracts, so as to protect the young growth against sheep and goats. Assuming that this will be accomplished, the next question arises, what is the best mode of treating these forests? What we know of the coppicing and pollarding power of this tree does not encourage the hope that coppice or pollards of Karshu at this elevation will prove sufficiently productive; experiments should nevertheless be made at once to determine this point. These experimental cuttings will be apart from the general plan. Two pattern areas, each about 2 acres in extent, if possible on slopes of different aspect, well stocked with Karshu poles, should be selected. The poles should be cut close to the ground, the cut should be slanting, or in the case of larger stems be trimmed, so as to be convex. A few poles here and there should be cut 2 or 3 feet above the ground, so as to see whether pollard shoots will come up more vigorously, and it will be well, in part at least of the areas selected, to leave the older trees standing for seed and shelter, so as to facilitate the re-stocking of these slopes, in case, what is probable, the coppice should prove a failure. Half of each of the two areas selected should be cut over early in spring, and half a month later. These were the suggestions which we agreed upon in autumn last, and, as explained above, they have to a certain extent been carried out. The seed ripens early in the rains, but at this elevation the Karshu does not seed every year. There was no seed in 1874, but there was a heavy crop in 1873, and consequently the ground under the trees is now everywhere covered with the seedlings of that year, most of which will, of course, perish, unless light is given. Nearly every blank in the forest is covered with young growth of more advanced age, and it seems probable that Karshu forests can readily be reproduced by means of two successive cuttings, provided a good seed year precedes or follows the first cutting. The extent of the first cutting must be determined by experience; sufficient light must be given to enable the seedlings to grow up, and sufficient trees must be left for seed and partial shelter. As it is desirable for many reasons to

encourage the growth of mixed forest, all vigorous coniferous trees found scattered in Karshu forests should be spared at the time of the first cutting. The Karshu of the Deoban hill is a slow growing tree, with 15 rings per inch of radius on the average. Appendices 4 and 5 give a statement of rings counted on the section of 15 stumps of large, and of 103 stumps of small trees. The results may be stated as follows :—

Girth at 5 feet from the ground.	Corresponding radius (of wood only) on the surface of the stump.	Age in years.
1′ 6″	2·0″	40
3′	5·7″	86
4′ 6″	8·6″	138
6′	11·5″	192

Cuttings in forests consisting of equal proportions of Karshu and coniferous trees must be regulated by the requirements of the principal kinds composing the forest. In most forests of this description there is young growth on the ground, and the aim must be to favor its development by giving sufficient light overhead.

(6.) *Moru, Quercus dilatata.*—Only found intermixed in small numbers in the Deoban forests. Seed ripens at the close of the rains: a good seed year in 1873; no seed this year. Moru as well as isolated Karshu should be spared in all coniferous forests, as a mixture of leaf-bearing trees is useful for improving the soil.

(7.) *Bán, Quercus incana.*—The Darna and Mátkángra blocks are mainly stocked with this tree, but no special provisions are required, except to thin out in groups and masses as soon as successful planting has commenced. Experimental plots of mature and pole forests should be cut over to determine the coppicing power of the tree. This, however, should only be done in case cattle and fire can be kept out from the blocks in question. The seed ripens in winter or early in spring, and there was a heavy seed year in 1874.

General rules of treatment

33. It is not probable that any large portion of the Deoban forests will be treated as coppice woods; the best system here will probably be that of high timber forest, both for Oaks and coniferous trees, and although we may hope eventually largely to aid natural reproduction by planting, particularly in the case of Spruce and Deodar, yet, considering the high elevation, the steepness of most of the slopes, the heavy downpour of the monsoon rains, and the two dry seasons of spring and autumn, it is exceedingly doubtful whether it will here be right anywhere to make complete clearances, and to plant. There will therefore be two systems of cutting, either by selection of individual trees, or by a series of two or more successive cuttings, with the view of removing the whole, or nearly the whole, of the mature trees in one compartment. The first-named system, which is known as *jardinage* in French, and as *plänter* or *fehmelhieb* in German forest terminology, we will briefly designate as selection felling, while the second may be called the system of successive cuttings.

System of successive cuttings

34. Speaking broadly, the system of successive cuttings is applicable only in compact forests on moderate slopes, and with plentiful soil. Our experience in the management of these forests is not sufficiently advanced to enable us to fix a limit of gradient in all cases beyond which successive cuttings should not be made. In ordinary cases a gradient of 35 degrees may be taken as the limit. Generally it may be said that selection fellings are necessary whenever it is desired not to expose any considerable extent of the ground to the action of sun and rain, and to guard against the drying up and washing down of the loose soil. They are not admissible on exposed ridges, though the slope may be gentle, nor in forests where, for other reasons, the ground must uninterruptedly be kept under cover. This system can only be adopted with any hope of success where sheep and goats are completely excluded. In forests of nearly uniform age the object aimed at is the production of evenly compact masses, the trees in each compartment being of the same age. In such forests cattle may without risk be admitted after the forest has attained a certain age,

and after the trees are beyond the reach of cattle. But with insignificant exceptions, we have no such forests of uniform growth in the Deoban circle, and we cannot, therefore, hold out any hopes of being able eventually to open a considerable area to cattle. The details of the arrangement of successive cuttings cannot here be prescribed for all cases; they must be determined by further experience. Thus the main object of the first cutting is to induce the trees to produce seed more freely, to prepare the ground for the reception of this seed, and to give sufficient light for the seedlings to spring up. After the ground is sufficiently covered with young growth, the remainder of the large trees may be cut out, and this final cutting may, according to circumstances, be made in one or several instalments. In determining the course to be pursued in each compartment, the principal aim must be to stock the ground with young growth as speedily as possible, and to obtain the greatest possible annual increase from any growth of intermediate ages which may be left on the ground. Where it can be done without interfering with these main objects, endeavours should be made to stock each compartment or definite portion of it (sub-compartment) with forest of uniform age, so as gradually to attain a complete gradation of ages. The advantages of high timber forests, consisting of a regular gradation of ages, are immense, but the prevalence of steep slopes in these forests, and their present very irregular character, will render any great progress in that direction exceedingly difficult; and, under these circumstances, we are not justified in encouraging the sacrifice to any great extent of the increase of the growing stock in order to attain this otherwise desirable object. The best guide in the arrangement of these cuttings will be the study of the requirements of our forest trees in the matter of light and shade, and in this respect it may here be stated, that the result of our experience, as far as it has gone, is that *Pinus excelsa* and *Pinus longifolia* require most light when young, and are most impatient of cover; that the young growth of *Abies Webbiana* and Oak requires much shade; and that Spruce and Deodar occupy an intermediate position in that respect. It must not, however, be lost sight of, that the requirements of forest trees with regard to light and shade vary somewhat with regard to elevation, gradient and aspect of the slope, and that young growth of the Spruce for instance, at high elevations and on slopes with a northerly aspect, comes up readily and seems to thrive on perfectly bare hill-sides without any shelter whatsoever.

Some suggestions regarding the treatment of certain portions of the forests by means of successive cuttings will be found in the specimen of a descriptive account of compartments, with proposals for working them, which is given in the Appendix.

System of selection fellings.

35. By far the majority of the forests in the Deoban Circle must be treated on the system of selection fellings. In all, or nearly all, compartments for which the system of successive cuttings is here recommended, there will be found patches of steep or rocky ground, where clearances even of small extent would be mischievous, and where, consequently, all fellings must be limited to the removal of a few trees here and there. The same system should be adopted in the case of all exposed ridges, the top of the Deoban hill, and the precipitous slopes of which the greater portion of the forest area consists, and should generally apply to a belt about 50 yards wide on either side of the crest of main ridges. Protection belts, in which individual trees only must be cut out, should also be left on both sides of ravines or water-courses, along blank lines caused by snow or the rolling of stones, as well as on the edge of all larger blanks within forest limits. All these belts must either be left entirely untouched, or be thinned out very sparingly. The same treatment must also for the present be applied to the greater part of the Mohna block, where the forests consist of young growth of various ages overtopped by old trees. And an additional object for selection fellings in this block is the necessity of preventing denudation of the slopes forming the catchment basin of the stream which feeds the present water channel of Chakrata. These suggestions must not, however, be misunderstood. The fundamental rule which should guide all cuttings by selection, is to cut out mature trees whenever there is a sufficiency of young growth on the ground. The system of successive cuttings necessarily entails clearances of greater or less extent, made with the view of inducing young growth to come up; the system of selection fellings, on the other hand, permits

cutting only where the ground is already stocked with young growth. These are, so to say, the extremes of the two systems, but it will be readily understood that there are intermediate modes of treatment. As a rule, the system of successive cuttings produces a larger annual yield per acre from any given forest than the system of selection fellings, but the latter system is capable of great development, and extensive forest estates in the Schwarzwald, consisting of the European Spruce and Silver Fir, which are managed on a system of carefully regulated selection fellings, produce a large yield per acre both in material and in money returns. It must, however, be said that precipitous rocky slopes are the exception in these forests, whereas they are the rule in the Deoban circle, and it is that which renders the question of the permanent fuel supply to Chakrata from this source a matter of great difficulty.

In conclusion, it should here be stated that the system of cutting by selection is the only one admissible in those blocks from which cattle cannot be excluded. It stands to reason that in such places large trees should not be cut until the ground in their immediate vicinity is stocked with young growth beyond the reach of cattle, provided it is intended to maintain the forest in such places.

Reproduction of the forest how to be ensured.

36. The first condition of a satisfactory regeneration of the forests is the exclusion of fires—and fires have steadily been kept out since 1870, thanks to the good arrangements and vigilance of the local officers. The second condition is the exclusion of cattle, particularly of sheep and goats. As already stated, this has been accomplished in the larger portion of the Mohna block since 1872, and it is proposed at once to close part of the Matkángra block with the view of planting on a large scale. The satisfactory progress of young growth in Mohna, and the unsatisfactory reproduction in the former cuttings of Jádi, Kanjátra, Durani and Thona, shows that cuttings, without excluding sheep and goats, will result in the deterioration of the forest. It has also been explained that, owing to the irregular character of the forest and to the steepness of the slopes, we cannot attempt to base any plan of operations upon a system of periodically closing one block after the other. What we must aim at is to obtain complete control over a limited area, and to provide elsewhere for the requirements of the neighbouring villages. Unless this can be accomplished, it will not be possible to provide from the Deoban forests a permanent supply of wood for Chakrata. Under these circumstances it is better to face the difficulty and at once to consider what extent may be closed at the least possible inconvenience to the people. After carefully considering the question with the local officers, I have come to the conclusion that we must endeavour, if possible, to obtain control over the area indicated on the map. This area includes the greater part of Mohna, Matkángra, Thona, Kutniar, and Asmári, and a portion of Darna, Jádi, Kophti, Kanjátra, Durani, and Hajawa. The extent of this area is probably about 4,500 acres. It will be noticed that this, together with the area supposed to be available for planting in cantonments, makes up 6,000 acres, which, if well stocked and free of grazing rights, may be expected to furnish permanently the annual requirements of Chakrata at the present rate. But it is not all free of grazing rights, and neither the land within cantonments, nor the 4,500 acres proposed to be closed in the Deoban circle, are well stocked. A large portion is blank, and of the slopes under wood, a proportion are steep and precipitous, and must be classed as nearly unproductive.

However, whether the area here indicated is sufficient to meet the requirements of Chakrata in this respect, or not, there can be no doubt that a commencement must be made by securing in the first instance complete control over this area. Regarding the necessity of this step there can be no doubt. In its present state the area proposed to be closed will certainly be found insufficient to furnish a permanent supply of fuel to Chakrata, but it will at least secure a portion of that supply. The main difficulty to overcome will be to provide high level grazing ground for the sheep and goats of those villages of Danau and Missau which have hitherto grazed from spring to the end of autumn in the vicinity of the Thona ridge. This can only be obviated by giving them access over Deoban hill to the high grazing grounds to the east of Kaunti Láni. Of the area which it is proposed should ultimately be closed, the greater portion of the land comprised in the Mohna block is closed already, and as far as the

interests of the villagers are concerned, the blocks which may next be closed are—

(*a*) The Matkángra block.

(*b*) Upper part of the Jádi block.

(*c*) The Kanjátra block, with a corner of Durani.

(*d*) The Thona block.

The closing of Kophti, Asmári and Darna, must follow at a later period.

Planting and sowing

37. We cannot expect that the whole of the ground where cuttings are contemplated will be regenerated by self-sown seedlings; natural reproduction, therefore, must be supplemented by cultivation, and, in addition, it is necessary to extend and consolidate the forest by planting up bare slopes as much as possible. This must be done in accordance with a regular plan; and the first point to be attended to is to concentrate operations as much as possible. For the present I suggest that planting and sowing should only be carried on in three blocks, Matkángra, Thona and Mohna.

The proposed operations in Matkángra have already been sketched; they are quite separate from the work in the rest of the Deoban forests, and may be taken up in connection with the planting of the waste lands within cantonments, in the event of this work being entrusted to the Forest Department.

The Thona nursery mentioned in paragraph 25, is in a locality particularly suitable for Spruce, and the experimental cultivation of that tree should be continued within a fenced area of that block. It is probable that after some years' experience Spruce will be found easy to cultivate on a large scale, and experiments with that tree may at the same time be made in the Mohna block.

The experimental cultivation of Karshu, Silver Fir, the Horse Chestnut, the large Maple (*Acer cæsium*), Jamun (*Prunus Padus*), the Alder, and other leaf-bearing trees, must for the present be confined to the Mohna block, where one high level nursery near Deoban, and another at a lower level at Deothat, may be maintained.

Eventually, when sufficient experience has been gained in this matter, nurseries will be established in the vicinity of the slopes to be planted up; but as long as these operations are experimental, they must be concentrated as much as possible. If it could have been arranged, the best plan would have been to have at the outset one central nursery only, in a locality accessible throughout the year. Matkángra is accessible in winter, but the locality is not suitable for all kinds of trees, and under these circumstances it is necessary to proceed with the plantation work simultaneously in other blocks. Should the efficient supervision of planting and sowing in Thona offer any difficulties, it must be given up, so as to concentrate this work in Mohna and Matkángra at present.

In the case of Karshu and Moru, the present system of dibbling in the seed should be continued; but endeavours should at the same time be made to raise strong plants in seed beds, which should be transplanted into nurseries after pruning them and cutting back the tap root It is not impossible that in this manner large and strong Oak saplings, 4 to 6 years old, may with great advantage be planted out in the forests. Such plants will be found useful in exposed places and on precipitous ground. Spruce will probably succeed best by planting, and so will Deodar. The cultivation of the Silver Fir will probably be found a difficult task. The excellent success in rearing plants of the Himalayan Chestnut at Deoban should be followed out. The magnificent mixed chestnut and Spruce forests between Datmir and Shaura illustrate the beneficial effects of a mixture of this tree. Seed beds and nurseries should not be established in hollows or other localities particularly exposed to late and early frosts during the growing season. The soil should be carefully prepared; it should be thrown through a standing sieve and mixed with vegetable mould. The beds should be dug out, and should consist of good loose soil 6 to 9 inches deep, placed on a hard surface. They should be level, not more than 3 or 4 feet wide, and the seeds should be sown and the plants bedded out, close together, in lines across the beds, the distance between the lines being sufficient to admit of the soil being thoroughly worked and convenient for the digging up of the plants. The distance between the lines must vary according to the kind of tree sown and the age of the plants. Seed beds and nursery beds must, in the case of all coniferous trees, be shaded by slanting screens during the dry months of spring and early autumn.

Autumn sowings, and rain transplants into nurseries, have hitherto been

found to succeed, but late autumn transplants should also be tried. The sowing time must, to a certain extent, be regulated by the season when the seed ripens.

Sowing and planting in the forest should in all cases be done in lines parallel to the slope of the hill, the lines being 10 or 15 feet apart, so as to facilitate control and reduce expense.

Order of cuttings

38. The order of cuttings must be guided by two considerations: the quantity of young growth on the ground, and the power of closing the forest after cutting. Under these circumstances it is evident that the first regular cuttings should be made in the Mohna block, the main part of which has been closed for two and a half years, and where young growth is abundant. In Mohna there is no doubt that cattle can be excluded, and in most parts the removal of the old trees is urgently necessary in order to make room for the young crop. Here, therefore, we are certain that the result of the cuttings will be beneficial; whereas if we were now to cut in Thona or Kanjátra, where there is little, and in many places no young growth on the ground, and where it is as yet uncertain whether grazing can be excluded, the result of our cuttings would, to say the least, be extremely uncertain. The unsatisfactory results of former cuttings in Jádi, Thona, Kanjátra and Durani, as regards reproduction, should be a warning not to cut in these compartments before sheep and goats are excluded and further experience has been gained regarding the treatment of Spruce. There is, however, this apparent disadvantage, that Mohna is comparatively near to Chakrata, and that, consequently, the cost of the first year's fuel will be less than that of subsequent years; but this in reality is of no consequence whatsoever, for the price of fuel cannot possibly be regulated every year by the cost of that year's operations. The price must be fixed for a series of years on the basis of average rates. After the cuttings in Mohna have been completed, they should be extended to the Kanjátra block, and so be continued westward through the Thona, Kutniár, Asmári and Kophti blocks.

A large portion of this year's fuel supply will probably be met by wind and snow falls, a large number of which is due to the heavy storms of February last. In addition to what remains to complete this year's supply, upwards of 80,000 maunds of green wood must be cut at once, so as to have dry wood ready for carriage in 1876. It will, therefore, probably be necessary to cut from 80,000 to 1,20,000 maunds of green wood this year, the larger quantity being required only in case a regiment remains at Chakrata during the ensuing winter.

The cuttings will be limited to the Mohna block below the level of the compact and pure Oak forest which lies beneath "Snow View." They will consist of thinnings by the removal of all mature trees, wherever there is a sufficiency of young growth on the ground. Round blanks a belt of forest must be left intact. In the upper parts of the block where Karshu preponderates, this tree should be cut out in preference to the Pines, as it is desirable in such localities to encourage a larger proportion of coniferous trees. On the other hand, where Spruce and Silver Fir predominate, it is desirable to preserve the mixed state of the forests by cutting out a larger proportion of the Pines. These cuttings should be started on the main ridge near Kaunti Láni and should proceed southward in regular order through the whole block until the requisite amount is obtained. The thinnings should not be made in patches, but through the entire breadth of the forest, from the top to the bottom of the block. Should it be found in the course of the operations that too large a proportion of Oak is cut, then the part above the new path may be left untouched, but below it the limit of the thinnings must always be in a straight line down hill Should the Moru forests in the lower part of the block be found to yield too large a proportion of Oak, it may be advisable to exclude some of these from cutting also. As the work progresses, the spurs and other lines found convenient to sub-divide this block into compartments should be marked by stone pillars, so as to ensure these lines being surveyed and their areas ascertained. In some places it may be found practicable to form compartments of a fairly homogeneous character as far as the age and character of the forest growth on them is concerned; but this will not be practicable in all cases, and where it is not practicable, the best plan will be to arrange compartments in accordance with the natural features of the ground. The fuel cut in each compartment must be stacked separately, Oak and coniferous wood being kept apart.

In this manner the results of such thinnings per acre in different descriptions of forest will be ascertained. Should any areas of pure and mature coniferous forest be found, they should be demarcated as separate compartments or sub-compartments, and in such places the cuttings will be regulated by the quantity of light required to ensure the natural reproduction of the principal kinds of trees on the ground, or of those kinds the growth of which it is intended to favour. In such places the girth of the trees left standing should be measured, and by comparison with cut trees of similar size their cubic contents of stacked wood should be determined. In such compartments the fellings will furnish data regarding the crop on the ground in mature forests, but no large extent of these will be found in the Mohna block.

Regarding the cuttings to be made in Kanjátra and Thona, it will suffice to refer to what was said under the general remarks concerning selection fellings, successive cuttings, and protection belts. Here also the great principle must be to get the ground covered with young growth as speedily as possible, and an additional, but very important, consideration is to secure a suitable mixture of different kinds of trees in the forest. Spruce is the prevailing tree in these blocks, with a mixture of Karshu and Silver Fir in the upper, and of Moru and Deodar in the lower part. The two Oaks should be encouraged because they serve to improve the soil; Silver Fir should be favoured because its natural reproduction under shade is more certain than that of the Spruce, and the Deodar because its wood is more valuable than that of the other Pines.

While cuttings are going on in the Pine forests of Kanjátra and Thona, the requirements of Oak timber may be met from the pure and compact Karshu forests above Deothat, from the mixed forests of Karshu and coniferous trees in the upper part of Kanjátra and Jádi, and from any portions of the Mohna block which may be left untouched during the operations of the first year. It is quite impossible to make any estimate at present as to the quantity of Pine and Oak timber which will be yielded by the cuttings here suggested. It seems probable, however, that in order to make up the entire quantity annually required, some cuttings will have to be made outside the area proposed to be closed against cattle. These cuttings may at present be made in the shape of thinnings or selection fellings in the Durani and Bajamara blocks. More cannot be said at present regarding the order of cuttings during the next three years. Endeavours must be made as soon as possible to exclude sheep and goats from Kanjátra, the adjoining corner of Durani, Thona, and the upper portion of Jádi, and to make the closed blocks yield the requisite annual supply for as long a series of years as possible.

Preparatory work for framing a regular plan of operations.

39. From the preceding remarks it will be evident that what is most urgently wanted is certain information regarding the area required to furnish the requisite permanent supply for Chakrata. A final reply to this question can only be based upon the experience of many years; the following steps, however, are necessary to ensure progress in this direction:—

First.—A detailed topographical survey of the forests now included in the Deoban circle, and of the forests adjoining them on both sides of the main ridge.

Second.—The final settlement of the block boundaries, and the division of the blocks into compartments.

Third.—A detailed descriptive account of compartments, with a statement of areas, exhibiting separately the area stocked and that which is bare of wood. In those compartments where cuttings have commenced, this should comprise a complete and detailed record of the cuttings and thinnings made under this plan of operations.

Fourth.—An estimate of the growing stock of mature timber, and of the normal annual production of wood per acre.

Topographical Survey.

40. Regarding the topographical survey, not much need be said at present. In a separate report on the remaining forests of Jaunsar, it has been proposed to include in this survey the whole of the second class forests as far as the Jako Pass. For the blocks from which fuel for Chakrata is to be drawn, though in some cases the scale of 4 inches to the mile will probably be found most convenient, a larger scale would be preferable.

The selection of the topographical features to be represented on the map will not be difficult if the requirements of the management of these forests are duly borne in mind. The boundary marks of first and second class forests, the block boundaries, where fixed, roads, paths, main ridges, and principal secondary spurs, objects of more or less permanent character, such as fields, cultivated or deserted, buildings, masses and ledges of rock, springs, tanks, gorges, the junction of streams or ravines, wherever accessible, are essential. The lower course of the hill streams here can in most cases only be delineated approximately, as the beds are difficult of access, but the course of some of the feeders which take their rise in the forests can be surveyed, and will often be found useful to serve as boundary lines of compartments. It will be well to enter the elevation of as many points as possible, and it will be an advantage approximately to indicate the average gradient of the slope, wherever the ground is stocked with wood. Hill shading or contouring should not be attempted. Detail of a temporary nature, such as the limits of Oak or Pine forests and blanks, may be approximately surveyed, but should not be represented on the printed map. Such details will be entered by hand on those copies which are intended to represent the present state of the forest. If it should not be practicable to include it in the present survey, then it must be entered by the local forest officers, for the data are required in order to determine the area of blanks and the area stocked with different descriptions of forest.

The survey should, if possible, commence early this autumn, for it is essential that the local officers should be furnished as soon as possible with accurate maps, upon which they can enter compartments and sub-compartments, and which will help them to determine the area of their cuttings.

Blocks and compartments

41. Blocks are geographical divisions, designated by a local name, which may or may not be stocked with one kind of forest. It was, indeed, considered whether the mass of Oak forest on the top of the Deoban hill should not be formed into a separate block, but there would have been no defined natural boundaries, and so there will be compartments stocked with Oak in the upper part of the Mohna, Kanjátra, and Jádi blocks. As the block boundaries will be well defined ridges, boundary marks will not be necessary throughout. Where they are required and for the demarcation of compartments, I would suggest posts of Deodar or the heart-wood of Oak let in 18 inches into the ground, and standing out the same height. One side should be flat and should bear a serial number.

The lines selected to form block boundaries will be extended to the forest boundary, but compartments will at present only be formed in that portion which it is proposed to form into a first class forest.

Compartments are intended as much as possible to comprise slopes of the same, or nearly the same, aspect, and forests of a similar if not uniform character requiring the same or nearly the same treatment. Thus a slope with a northerly aspect would be formed into one compartment, if the forest were of nearly the same character throughout. But if one portion, for instance, mainly consisted of mature trees, and the other of trees of the younger classes, then they would be divided into two or more compartments by natural or artificial lines. Again, if the upper part of the slope consisted of Oak or mixed forest, and the lower part of coniferous trees, then the upper portion would, if of sufficient extent, form one compartment; while the lower part of the slope would, according to circumstances, form one or several distinct compartments, but areas of *small* extent in which the forest has a character different from the rest would not be formed into separate compartments.

The varied nature of the Deoban forest will, in many cases, make it impossible to form compartments uniform in character as regards present forest growth; in such cases, therefore, their boundaries will be determined by the configuration of the ground and by convenient boundary lines, such as roads, ravines, ridges, and the like. Hence it will be evident that in working these forests we must deal not so much with compartments as with portions and sub-divisions of compartments, or sub-compartments as we may call them. The treatment of each compartment must, as a rule, be determined on its merits, in accordance with the character of the forest with which it is stocked, and with the view of obtaining from it the largest possible permanent yield; but there are numerous cases when the treatment of one compartment

will be influenced by the character and treatment of the adjoining compartments, by considerations connected with grazing and other rights and the export of wood and timber, or by the general scheme of the working plan.

It is evident that a satisfactory division of blocks into compartments can only be made after a detailed study of each block on the ground, and it will be preferable in the blocks in which cuttings have not yet commenced, to delay this work until a few years' experience of cutting by compartments has been obtained. The local knowledge of the present officers should, however, be utilized as much as possible in this matter, and the compartments should be formed in all blocks in which fellings have been commenced.

Description of compartments.

42. As each compartment is formed, a detailed description of it, with proposals for its treatment, must be drawn up and recorded. This, next to the topographical survey, is the most important work preparatory to the drawing up of a regular plan of operations. The record will consist —

(1.) Of a detailed description of the compartment, arranged in the same way as the sketch of specimen compartments of the Thona and Kanjátra blocks given in Appendix No. 1.

(2.) Of an account of its previous treatment, including any cuttings and thinnings now undertaken.

(3.) Of the proposals for its future treatment.

In the first part the boundaries should be fully detailed, and the grounds for selecting them, and a description with a statement of areas, should be given of each portion of the compartment. The second part should explain the nature and object of the cutting in each sub-compartment, its area, the number of trees cut, and the quantity of material removed; also the number of mature trees remaining and their estimated contents, as well as a general account of the younger classes left standing.

In these statements it will suffice for the present to keep Oaks and coniferous trees apart, without attempting a distinction between the different kinds of the former and the different descriptions of the latter.

Estimate of growing stock and of annual possible yield.

43. The determination of the annual possible yield of these forests is the great aim towards which we are working at present. When that has been ascertained, it will be possible to say whether the area here suggested will suffice, or whether an extension of operations will be necessary. The first question here is, whether the normal yield should be expressed in weight, or in stacked or solid wood. It will not be difficult to explain that a cubic foot of solid wood is the only satisfactory unit which is applicable in all cases. The weight of wood varies with the moisture it contains, and the actual contents of 100 cubic feet of stacked wood is different in the case of Oak and coniferous trees, in the case of stem and branch wood, and varies with the length and description of the pieces. Moreover, unless the cubic contents of solid wood is used, timber must always be recorded separately. Eventually, therefore, the estimate of the growing stock, as well as of the annual production and yield, must be expressed in cubic feet of solid wood. The mode of procedure for determining the solid contents of stacked wood will be indicated further on; but as it will entail a considerable amount of labour, and the needful officers for this work may not be available, it will be expedient for the present to maintain 100 cubic feet of stacked wood as the unit of measurement. The question is, what is the quantity of the mature growing stock, and over how many years must the cutting of it be spread, so as to last until the younger classes are ready to take its place. If the forests were more regular in character, all that would require to be done would be to determine the area stocked with forest of different descriptions and ages, and from these areas, as well as from the ascertained rate of growth, and the quantity of mature growing stock, to calculate the possible yield during the first period of the working plan. But the forests are not regular, and this plan, therefore, is impracticable. In what manner this object is to be attained must be determined when a complete descriptive account of all compartments has been drawn up. At present our knowledge of these forests is insufficient to lay down the mode of procedure. But, in order to prepare a satisfactory record of compartments, it is necessary to agree upon the classes of trees to be adopted; and this must be done separately for Oaks and coniferous trees.

Classification of trees

44. From what was said regarding the rate of growth of Spruce and Silver Fir, and from the details given in the Appendix, it will be noticed that the available data give a more rapid rate of growth to the silver Fir than to the Spruce. These data, however, are too scanty to admit of final conclusions, and, pending the collection of further data, we will adopt the same classification for Spruce and Silver Fir, in which for the present Deodar may also be included. I suggest the use of the following terms and classes.—

1. Old trees, above 6 feet in girth and above 120 years of age.
2. Trees, from 4 „ 6 inches to 6 feet in girth and from 90 to 120 years of age.
3. Large poles, „ 3 „ to 4 feet 6 inches „ and from 60 to 90 „ „
4. Poles, „ 18 inches to 3 feet „ and from 30 to 60 „ „
5. Saplings under 18 „ in girth and under 30 years of age.

Seedlings and thickets are the youngest stage of the last class. This classification must not be applied with mathematical precision; age and size classes can never tally exactly, because the rate of growth varies exceedingly according to circumstances. Regarding the conditions which affect the rate of growth in these hills, I beg reference to the remarks recorded in the Bussahir Forest Report of 1864. On the top of the Deoban hill, and on steep slopes, it will be found that these trees do not attain 6 feet in girth until they are 150 to 200 years old, and on gentle slopes, at a lower elevation, the growth will be found to be much more rapid than what is here stated. As a rule, it will possibly be found that some of the classes here indicated mark certain periods in the growth of the tree. Thus, during the first period, the thickets of young growth clear each other of their lower side branches, and this process is completed long before the age of 30 years is attained. By that time the poles, if grown up in close thickets, have mostly clean and tall stems, though they have only reached a small part of their height. While passing through the stage of poles, they continue to increase both in girth and height, and by the time they have become trees, they will be found to have completed their full growth in height. By that time also they commence to seed freely, that is, in places where they have sufficient light and sun.

Regarding all these matters, however, further observations are needed, and on no point more than the age when the Spruce and Silver Fir commence to shed seed in the different blocks of the Deoban circle. As noted above in the description of blocks, the want of young growth in some of the former cuttings in the Jádi and other blocks has been ascribed to the fact that the trees were not old enough to bear seed, though they had attained a considerable size. On this subject more observations are urgently wanted, for the age at which they may be cut must mainly in these forests depend on the age when the trees commence to seed freely. Fuel, and not large timber, being the principal article required from these forests, it will probably be found best to work them on a short rotation, and not to allow the trees to attain a greater age than is necessary for the production of self-sown seedlings.

For Karshu the following classes may, for the present, be adopted—

1 Old trees above 4 feet 6 inches in girth and above 140 years old
2 Trees from 3 „ to 4 feet 6 inches in girth and between 90 to 140 years old.
3 Poles „ 18 inches to 3 feet in girth and between 40 to 90 years old.
4 Saplings below 18 „ „ and below 40 „

Karshu does not ordinarily attain any large size, and four classes, therefore, will probably be sufficient No observations regarding the age, when the growth in height is completed and when the tree commences to seed freely, are available; nor is anything known regarding the rate of growth of Ban or Moru.

Record of growing stock

45. In drawing up the record of the growing stock in each compartment, the best plan will be to enumerate all trees above 4 feet 6 inches in girth, and to record girth and height in sub-classes, as will be explained further on. The trees of the smaller sizes will then be entered by area. This will not be difficult where separate sub-divisions of any compartment are stocked with one class of forest. This, however, is a case of rare occurrence in the Deoban forests, and in most cases the classes are mixed. Blanks, and areas so sparsely stocked as to be classed as blanks, can always be measured. If, after subtracting these, the remainder of the compartment is evenly stocked with poles and saplings, half the area will be entered as stocked with one, and the

other half with the other class. If the poles predominate, 60, or, as the case may be, 80 per cent. of the area will be shown as stocked with poles. In this manner a statement may be prepared for each compartment, exhibiting an approximate estimate of the cubic contents of the larger trees and of the area stocked with the trees of the smaller classes.

It should now be explained how the cubic contents of the standing trees of the larger classes may be determined. The contents of a tree, including its branches, may be regarded as a portion of a cylinder, the base of which is the base of the tree, and the length is its height. The co-efficient or fraction, which, multiplied with the cylinder, gives the cubic contents of the tree, we have agreed to call the reducing factor. It is evident that the value of this reducing factor varies with the shape of the tree and its branches, and that certain classes should be established, for each of which a reducing factor must be determined. This is a large task, which requires long and systematic research, and entails the analysis of numerous sample trees. In the present case we will limit our researches to the determination of a *mean reducing factor* for each kind of tree with a girth exceeding 4 feet 6 inches. Such a mean factor being determined, all that is required for determining the cubic contents of the trees in one compartment is to multiply the aggregate sectional area of each height class with the average height of the trees in that class, and to sum up the results. It is obviously immaterial at what height from the ground the sectional area of the base is taken, provided it always is taken at the same height. For the Jaunsar forests I would suggest 5 feet.

Mean reducing factor how determined.

46. The value of this mean reducing factor must be ascertained by the analysis of a number of sample trees of different height and girth above 4 feet 6 inches. At present I would suggest that ten trees of each of the three principal kinds—Spruce, Silver Fir, and Karshu—be analysed. The procedure will be as follows:—

1*st.*—Age and rate of growth to be ascertained by counting the rings on a mean radius of the stump from 2 to 2 inches.

2*nd.*—Girth at 5 feet from the ground, and total height to be measured.

3*rd.*—Cubic contents to be determined by actual measurement in the following manner:—The stem to be logged, all symmetrical pieces to be measured, and their contents to be calculated as cylinders by their mean diameter, the cubic contents of all irregular pieces and small wood, as far as saleable, to be determined by stacking.

The details of the analysis of sample trees should be entered in the following tabular form:—

DEOBAN WORKING CIRCLE.

BLOCK MOHNA—COMPARTMENT No. 3.

Analysis of sample trees.

No.	Species.	Age.	Height	Girth.	Length of section.	Mean girth of section.	Cubic contents.	Results.	
		Years.	Feet.	Inches	Feet.	Inches.	Cubic feet.		Cubic feet.
1	Spruce .	140	100	70	10	70	27		
					10	66	24	Ideal cylinder ...	= 270
					10	63	22	Reducing factor 119/270	= 0·44
					10	57	18		
					10	45	11		
					10	36	7		
					10	24	3		
Add cubic feet of stacked branch wood equal to solid wood					...	...	7		
Total cubic contents of the tree (solid wood)...					...	...	119		

Solid contents of stacked wood how ascertained.

47. These are the operations to be performed on the spot in the forest. What remains to be done is to determine the solid contents of the stacks, which will chiefly consist of irregular wood. This must be done at the depôt by the displacement of water; the identical stacks cannot, of course, be thus measured, but the needful data will be obtained by determining the proportion of solid and stacked wood of stem and branches of the principal kinds. In these experi-

ments Spruce and Silver Fir need not be separated ; there will thus be the following stacks to be examined :—

1. Pine ... ... Stem wood.
2. Do. ... ... Branch do.
3. Karshu ... ... Stem do.
4. Do. ... ... Branch do.

Upwards of 1,000 cubic feet of each kind should be examined to obtain satisfactory results. The solid cubic contents of each stack will be determined by successive immersion of the pieces composing it in a graduated tank with tap and spout. The details of the analysis of stacks should, as this work progresses, be entered in a tabular statement in the form given below :—

DEOBAN WORKING CIRCLE.

CHAKRATA DEPÔT.

Analysis of branch wood stacks—Silver Fir and Spruce.

Number of Stacks.	Measurement.	Cubic contents by displacement of water.	Percentage of solid in stacked wood.
1	200 cubic feet.	150 cubic feet.	0·74
2	300 „	200 „	0·66
3	100 „	60 „	0·60
4	100 „	60 „	0·60
Total ..	700 cubic feet.	470 cubic feet.	0·67 average.

Cubic contents of standing stock, how determined.

48. If the measurements and experiments suggested in the preceding paragraphs are duly carried out, it will not be difficult to calculate the solid contents of the stacked produce of any compartment, and to determine the cubic contents of standing trees by measuring height and girth. In order to register the standing trees of any compartment expeditiously, the best plan will be to register them in girth classes from 6 to 6 inches, and in height classes from 20 to 20 feet. As already explained, it is not contemplated at present to register any trees below 4 feet 6 inches in girth, and all trees registered will probably have attained their full height. Thus, apart from suppressed and isolated trees, there will not in one sub-compartment be any great difference in the height of registered trees. In a fairly well-stocked forest, the first step should be to examine the height of the leading trees, and it will often be possible to class all the leading trees in one height class.

Conclusion.

40. These remarks must suffice regarding the data to be collected, upon which hereafter to base a regular plan of operations. During the next three years we can only take the first steps, but they are indispensable, and an attempt must be made to accomplish the following work before April 1878 :—

1*st*.—The topographical survey.
2*nd*.—Reducing factor for Spruce, Silver Fir and Oak.
3*rd*.—Factor to convert stacked wood into solid wood.
4*th*.—Demarcation, area statement, and descriptive account of compartments.
5*th*.—Register and cubic contents of standing timber above 4 feet 6 inches girth in all compartments.

The details of all researches and operations prescribed in the preceding paragraphs should be fully recorded, but in addition it will be necessary to keep a complete periodical record of the progress of operations, of all noteworthy occurrences relating to these forests, and of the receipts and charges on their account. This book (to be designated 'Journal of Deoban Working Circle') should, as a rule, be written up at the end of every month. Certain entries, such as the progress made in the closing of blocks against sheep and goats, or in large works, such as demarcation lines, roads, tramways and the like; an account of the seed production of the different kinds of trees, and an abstract of the rain (and snow) fall, if possible, may be entered at the close of the year; but

whatever facts of interest can be noted monthly, should be noted at the close of every month, including monthly abstracts of receipts and charges. This book is not intended in any way to supersede the plantation journals, which must, as heretofore, be kept separate for the nurseries and planting operations in each block.

30. The present report is the result of an examination of the localities in November 1874 and April 1875, in company with the local forest officers, and at Chakrata with the military authorities. It gives me pleasure to express my obligations for the assistance and information received, and I desire particularly to thank Mr. C. Bagshawe, the officer in charge of the Jaunsar Forest Division. During my visit in November last, I was also accompanied by Mr R. Ribbentrop, now Officiating Conservator of Forests in Burma, and had the advantage of his advice on several points.

SINCE the above was written, Mr. Bagshawe has favoured me with the following corrections :—

Page 8, *paragraph* 18.—The cost of carrying 100 maunds of fuel now amounts to about Rs. 4-4 per mile, so that the cost of delivery from an average distance of 6 miles is as follows :—

		Rs	A.	P.
Cutting, collecting and stacking ...		5	0	0
Carrying 6 miles ..		25	8	0
Total ..		30	8	0

Page 11, *paragraph* 24.—The quantity of wood yielded by wind and snow-falls is much larger than was anticipated, and the cuttings in Kanjátra, therefore, will not be required for the supply of 1876-77.

Page 13, *paragraph* 30.—The length of the fuel slide is nearly 1,250 feet.

APPENDIX I

Specimen of description and proposals for working of compartments.

NOTE.—Compartments 1, 2, 3, 4, of Kanjátra, were taken along the road from Deoban to Koti; No. 5, of Kanjátra, and 1, 2, of Thona, along the road from Bodya to Deoban. Description and proposals only relate to the forest in the vicinity of the road.

KANJATRA BLOCK.

COMPARTMENT No. 1.

Boundaries—From the junction of the Kailo road with the Deoban and Tonse road to the first ravine met on the Koti side. *Position*—On the left bank of the Kanjátra Pani khud, a feeder of the Marauwagad. *Aspect*—N. and N. W. *Slope* 30° to 45°. *Soil*—Plentiful; rock limestone. *Standing crop*—Silver and Spruce Fir, 120 feet high; average diameter 9″ to 18″; the greater part of the large trees cut out in 1869-70; blank spaces, few; ground incompletely stocked with young growth; underwood not heavy. *Proposals for working*—Thin out largely the trees of intermediate size, in order to induce the larger trees to produce seed.

COMPARTMENT No. 2.

Boundaries—Between compartment No. 1 on the east and the Marauwadhar on the west side. *Aspect*—N. and N. W. *Slope.*—Above 30°. *Soil*—Plentiful and moist; rock limestone. *Standing crop*—Spruce and Silver Fir in equal proportions, 120′ to 150′ high, diameter 9″ to 24″; standing crop incomplete; large trees cut out in 1869 and 1870 and previously by villagers; young crop in patches complete, 10′ to 20′ high. Silver and Spruce Fir, the former in proportion of 4 to 1 of the latter; blanks sparsely covered with young Spruce; undergrowth willows and ringall, a few Moru and *Pinus excelsa* trees in this compartment. *Proposals*—Cut out trees over 12 inches in diameter, leaving groups of healthy trees in vicinity of blanks to shed seed.

COMPARTMENT No. 3.

Boundary—Continuation of compartment No. 2 to dry ravine that runs down from Kanjàtra Láni. *Aspect*—N. W. *Slope.*—30°, with patches of rocky precipice. *Soil*—Plentiful and moist. *Standing crop*—Spruce and a little Silver Fir, 60′ to 80′ high, diameter below 18.″ In the lower part the trees are larger but scattered, with numerous blanks between; young crop complete wherever there is space, mainly Silver Fir; undergrowth thick in parts of ringall and willows. *Proposals*—Thin out with a view to improve the growth of young crop, cutting all large trees, except in the lower part, where they are required to fill the blanks. No felling on precipitous ground. A fringe of trees to be left on either side of the dry ravine which forms the boundary.

COMPARTMENT No. 4.

Boundary—On the east by compartment No. 3; on the west by the Debi fields and water. *Aspect*—N. W. *Slope*—35° to 45°, mostly above 40°. *Soil*—Good, stony; rock, limestone and calcareous shale with thin strata, almost vertical. *Standing crop*—Complete; trees of various sizes, few exceeding 24″ in diameter, drawn up into tall straight stems. Spruce and a few Moru, Deodar, *Pinus excelsa*, and Silver Fir; undergrowth, isolated patches of ringall. The following Spruce trees were measured:—

(*a*)	8′ 9″	girth,	144′ high.
(*b*)	10′ 6″	„	135′ „
(*c*)	4′ 4″	„	107′ „
(*d*)	7′ 9″	„	120′ „

Proposals—On the more gentle slopes, clearances sufficiently large to enable the surrounding trees to shed seed, and for seedlings to come up; the larger trees to be left for seed and preferably in groups round clearances. All Moru and Deodar to be spared.

COMPARTMENT No. 5.

Boundary—East, Kanjátra Láni; west, Paniáwa water khud. *Aspect*—North. *Slope*—25° to 40°. *Soil*—Plentiful and moist. *Standing crop*—Very unequal, in many places incomplete, consisting of 2nd class trees, with a small proportion of 1st class trees in places; very little young growth; Spruce, with a few Silver Fir, Moru and Karshu. *Proposals*—Cut out all overbearing trees, where you can do so without damage to the 2nd class trees, the object being to improve the latter.

THONA BLOCK.

COMPARTMENT No. 1.

Boundary—West, the block boundary; east, Kandáyidhár. *Aspect*—North. *Slope*—30° to 40°. *Soil*—Plentiful and moist. *Standing crop*—Incomplete; tall trees above 24″ in diameter. Spruce the principal tree, with a varying proportion of Silver Fir; latter more plentiful in places; undergrowth varied; patches of Silver Fir promising, Spruce the reverse. *Proposals*—On gentle slopes clear everything except vigorous poles and young growth, and in large clearances a few seed-trees, giving preference to Silver Fir; all Moru to be spared; no cuttings on precipitous ground or on secondary ridges; protection belts 50 to 100 yards wide to be left below main ridge; round grassy slopes a circle of trees to be left at discretion.

Compartment No. 2.

Boundary—Continuation of former compartment to eastern boundary of block. *Aspect*—North. *Slope*—30° to 40°. *Soil*—Plentiful and moist. *Standing crop*—Unequal and incomplete, mainly Spruce and Silver Fir, the latter more abundant near the ridge, and lower down, in the proportion of one to ten of Spruce; a preponderance of poles up to 12" diameter. Young growth very unequal, in some places promising, particularly where there is protection by brushwood; in open places injured by sheep and goats. Silver Fir more promising than Spruce. *Proposals*—In places where large trees are more numerous, treatment as in No. 1; but where masses of poles preponderate, cut out the large and not vigorous poles. In such portions of the compartment we must mainly rely on planting for completing the future crop.

MOHNA BLOCK.

Compartment No. 1.

Boundary—Old Simla road to small ridge above Deothat. *Aspect*—N. N. E. *Slope*—20° to 25°. *Soil*—Abundant, black, with vegetable mould. *Crop*—Karshu complete, with a few Spruce; about 100 trees per acre of all sizes from 9" in diameter and upwards; 80' to 100' high; cover not complete; ground generally covered with seedlings 2 years old or older. *Proposals.*—Leave about 20 trees per acre, sparing all Spruce and the larger sound Oaks for seed. This is the first cutting; it should be made in spring, either in the year immediately following a good seed year, or when an abundance of young acorns gives promise of a full crop. If these precautions are observed, it is hoped that this first cutting will result in covering the ground with a thick crop of young growth; when this is complete, the remaining large trees will be removed, but the time when the second cutting should be made must also be determined by experience. The experimental nature of these operations makes it desirable that at first these cuttings should be made on a small area only.

Calculation of rate of growth in Appendix II.—(Spruce).

Average of all trees (67)

On 2 inches from centre	16·3 rings.	
„ 0·9 „	8·7 „	
On 2·9 inches	25 rings.	
On 4 inches from centre	35·7 „	
„ 1·7 „	19·1 „	
On 5·7 inches	54·8 rings.	
On 6 inches from centre	58·3 „	
„ 2·6 „ from 6th inch	31·5 „	
On 8·6 inches	89·8 rings.	
On 6 inches from centre	58·3 „	
„ 5·5 „ from 6th inch	66·7 „	
On 11·5 inches	125·0 rings.	

Average of trees 12 inches and above in radius (19)

On 2 inches from centre	13·7 rings.	
„ 2 next inches	13·3 „	
„ 2 „ „	14·2 „	
On 6 inches from centre	41·2 rings.	
On 2·9 „ „	19·9 „	
„ 5·7 „ „	39·1 „	
On 8 inches from centre	57·1 rings.	
„ 0·6 „ from 8th inch	5·9 „	
On 8·6 inches from centre	63·0 rings.	
On 10 inches from centre	76·9 rings.	
„ 1·5 „ from 10th inch	14·2	
On 11·5 inches from centre	91·1 rings.	

The calculation of the results given in Appendices III and IV was made in the same manner.

APPENDIX II.

DEOBAN WORKING CIRCLE.

Growth of Spruce in the Thona and Kanjatra blocks; rock-limestone; elevation about 8,500 feet.

No.	Name of Block.	Aspect.	Radius.	Age.	Rings. 0 to 2 inches.	2 to 4 inches.	4 to 6 inches.	6 to 8 inches.	8 to 10 inches.	10 to 12 inches.	Remarks.
			Inches.								
1	Kanjatra ...	N.-W.	14	85	11	8	13	13	13	15	13 rings from 12 to 14 inches.
2	,, ...	,,	12	85	8	10	12	16	21	18	
3	,, ...	,,	9	99	18	20	22	21	(18)	...	
4	,, ...	,,	11	87	10	12	16	21	17	(11)	
5	,, ...	,,	8	71	23	5	18	25	...	...	
6	,, ...	,,	6	60	13	19	28	...	...	...	
7	,, ...	,,	10	96	13	11	13	23	36	...	
8	,, ...	,,	10	139	15	28	28	36	32	...	
9	,, ...	N.	16	138	11	14	18	19	19	20	37 rings from 12 to 16 inches.
10	,, ...	,,	12	124	7	20	27	26	25	(19)	
11	,, ...	,,	14	144	18	16	14	17	26	24	29 rings from 12 to 14 inches.
12	,, ...	N.-W.	14	122	17	29	20	10	15	12	19 rings from 12 to 14 inches.
13	,, ...	N. N.-E.	7½	92	20	28	22	(22)	...	...	
14	,, ...	,,	13	89	16	10	10	15	13	17	8 rings from 12 to 13 inches.
15	,, ...	,,	13	98	13	9	9	19	18	17	13 rings from 12 to 13 inches.
16	,, ...	,,	14	115	8	10	10	12	12	24	39 rings from 12 to 14 inches.
17	,, ...	,,	12	103	12	8	17	21	20	25	
18	Thona ...	N.	17	128	9	8	9	15	23	31	44 rings from 12 to 17 inches.
19	,, ...	,,	14	134	7	10	17	29	29	23	26 rings from 12 to 14 inches.
20	,, ...	,,	11½	124	14	15	20	21	29	(25)	
21	,, ...	,,	7½	139	38	19	35	47	...	...	
22	,, ...	,,	12½	114	22	12	10	11	21	(38)	
23	,, ...	,,	9	122	19	14	26	40	(23)	...	
24	,, ...	,,	9	150	20	37	24	35	(34)	...	
25	,, ...	,,	14	127	13	12	11	13	23	25	30 rings from 12 to 14 inches.
26	,, ...	,,	5	97	21	46	30	...	...	...	
27	,, ...	,,	21½	153	13	21	11	11	11	7	79 rings from 12 to 21½ inches.
28	,, ...	N. N.-E.	21½	155	12	9	10	9	13	17	85 rings from 12 to 21½ inches.
29	,, ...	,,	7	66	15	20	24	(7)	...	...	
30	,, ...	,,	8	106	21	24	30	(31)	...	...	
31	,, ...	,,	7½	90	22	19	26	(23)	...	...	
32	,, ...	,,	12	107	25	12	10	10	19	31	
33	,, ...	,,	10	125	20	37	25	17	26	...	
34	,, ...	,,	7	107	28	27	23	(20)	...	...	
35	,, ...	,,	7	61	15	10	15	21	...	...	
36	,, ...	,,	6½	127	20	43	49	(10)	...	...	
37	,, ...	,,	8	103	17	30	31	25	...	...	
38	,, ...	,,	4½	83	29	46	8	...	...	...	
39	,, ...	,,	5½	89	43	30	16	...	...	...	
40	,, ...	,,	9	117	33	25	19	21	(19)	...	
41	,, ...	,,	8	96	15	14	28	39	...	...	
42	,, ...	,,	10	112	25	17	21	31	18	...	
43	,, ...	,,	7	84	17	18	26	(23)	...	...	
44	,, ...	,,	8	95	17	25	22	31	...	...	
45	,, ...	,,	5	80	15	31	(34)	...	...	...	
46	,, ...	,,	10	109	13	13	29	24	30	...	
47	,, ...	,,	6	94	15	21	58	...	...	...	
48	,, ...	,,	12	116	12	13	22	25	24	20	
49	,, ...	,,	8	81	14	14	24	29	...	...	
50	,, ...	,,	8	109	23	18	19	40	...	...	
51	,, ...	N.-E.	12	109	20	21	19	17	16	16	
52	,, ...	,,	6	87	25	26	36	...	...	...	
53	,, ...	,,	9	128	30	33	28	19	(18)	...	
54	,, ...	,,	15½	143	29	10	11	14	38	9	32 rings from 12 to 15½ inches.
55	,, ...	,,	8	83	12	14	22	40	...	...	
56	,, ...	,,	10½	107	20	19	21	20	22	(5)	
57	,, ...	,,	10½	104	20	14	16	22	27	(5)	
58	,, ...	,,	8	130	25	28	34	43	...	...	The figures (number of rings) in brackets relate to portions of radius, less (in a few cases more) than 2 inches, as will be seen from the length of radius in column 4.
59	,, ...	,,	8	93	15	19	26	33	...	...	
60	,, ...	,,	6	88	26	22	40	...	...	...	
61	,, ...	,,	10	99	16	13	20	30	20	...	
62	,, ...	,,	10	126	13	18	31	32	32	...	
63	,, ...	N. N.-E.	6	80	15	26	39	...	...	...	
64	,, ...	,,	8	110	12	28	30	40	...	...	
65	,, ...	,,	7	115	16	22	46	(29)	...	...	
66	,, ...	,,	8½	111	13	10	23	(65)	...	...	
67	,, ...	,,	9½	102	10	10	10	30	(42)	...	
	Total ...		664½	7,078	1,092	1,300	1,513	...	...	...	
	Average ...		9·9	105·6	16·3	19·4	22·5	...	...	...	

Rate of growth.

Girth of tree at 5 feet, in inches.	Radius of wood on surface of stump, in inches.	AGE IN YEARS. Suppressed trees. Included.	Excluded.
18	2·9	25	20
36	5·7	55	39
54	8·6	90	63
72	11·5	125	91

APPENDIX III.

DEOBAN WORKING CIRCLE.

Growth of Silver Fir in the Kanjatra block; rock limestone; elevation about 8,500 *feet.*

No.	Name of Block.	Aspect.	Radius.	Age.	Rings. 0 to 2 inches.	2 to 4 inches.	4 to 6 inches.	6 to 8 inches.	8 to 10 inches.	10 to 12 inches.	Remarks.
			Inches.								
1	Kanjatra ...	N.-W.	6¾	91	20	34	27	(10)	...	...	The figures (number of rings) in brackets relate to portions of radius, less (in a few cases more) than 2 inches, as will be seen from the length of radius in column 4.
2	,, ...	,,	7	94	27	25	24	(18)	...	...	
3	,, ...	,,	9	100	30	19	18	23	(10)	...	
4	,, ...	N. N.-E.	11½	95	9	10	13	18	25	(20)	
5	,, ...	,,	10	80	14	18	11	12	25	...	
6	,, ...	,,	14	133	9	14	11	15	15	30	39 rings from 12 to 14 inches.
7	,, ...	,,	11	103	16	25	24	18	13	(7)	
8	,, ...	,,	12	87	9	9	10	10	15	34	
	Total ...		81	783	134	154	138				
	Average ...		10·1	97·8	16·7	19·2	17·2				

Rate of growth.

Girth of tree at 5 feet, in inches.	Radius of wood on surface of stump, in inches.	Age in years.
18	2·9	25
36	5·7	50
54	8·6	81
72	11·5	113

APPENDIX IV.

DEOBAN WORKING CIRCLE.

Growth of Karshu in Kanjatra and Mohna blocks; soil, deep vegetable mould on stiff clay, overlying limestone rock; elevation between 8,500 *and* 9,200 *feet.*

No.	Name of Block.	Aspect and position on hill side.	Mean radius.	Age.	Rings. 0 to 2 inches.	2 to 4 inches.	4 to 6 inches.	6 to 8 inches.	8 to 10 inches.	10 to 12 inches.	Remarks.
			Inches.								
1	Kanjatra ...	W. high up.	10¼	129	22	27	25	22	18	(15)	The figures (number of rings) in brackets relate to portions of radius, less (in few cases more) than 2 inches, as will be seen from the length of radius in column 4.
2	,, ...	,, ,,	10	200	34	20	64	37	45	...	
3	,, ...	,, ,,	10¼	200	22	36	55	33	55	(8)	
4	,, ...	,, ,,	9½	174	23	55	37	36	23	...	
5	,, ...	,, ,,	9¼	193	18	53	34	48	(40)	...	
6	Mohna ...	E. ,,	9	164	38	44	36	29	(17)	...	
7	,, ...	,, middle.	9¼	137	46	23	19	21	(29)	...	
8	,, ...	,, ,,	9	95	15	12	23	32	(13)	...	
9	,, ...	,, ,,	8	142	37	36	30	39	...	...	
10	,, ...	,, ,,	7	125	27	32	42	(24)	...	...	
11	,, ...	,, low.	11	152	17	33	29	33	24	16	
12	,, ...	,, ,,	7¾	104	24	20	21	(39)	...	...	
13	,, ...	,, ,,	5	73	27	30	(16)	...	...	...	
14	,, ...	,, ,,	8	132	21	26	45	40	...	...	
15	,, ...	,, ,,	10¼	121	35	12	18	23	28	(5)	
	Total ...		134¾	2,150	406	458	494				
	Average ...		8·9	143·3	27·1	30.5	32·9				

Rate of growth.

Girth of trees at 5 feet, in inches.	Radius of wood on surface of stump, in inches.	Age in years.
18	2·9	40
36	5·7	86
54	8·6	138
72	11·5	192

APPENDIX V.

DEOBAN WORKING CIRCLE.

Growth of Karshu Coppice.

(Elevation about 9,000 feet.)

Jadi Block			Monna Block.					
No.	Inches in Diameter.	Number of Rings.	No.	Inches in Diameter.	Number of Rings.	No.	Inches in Diameter.	Number of Rings.
						Bt. over	303½	2,040
1	5	40	1	6	34	61	4	32
2	6	62	2	4	21	62	4	41
3	4	28	3	6	26	63	4½	40
4	7	45	4	4	24	64	4	38
5	6	35	5	5	30	65	3	32
6	5½	33	6	4½	25	66	4	38
7	5½	34	7	6	31	67	4½	42
8	4	28	8	6	35	68	4	37
9	5	26	9	3½	22	69	8	52
10	5	32	10	4½	27	70	1½	23
11	5	34	11	2½	15	71	2½	25
12	4½	31	12	5½	27	72	5½	43
13	6	44	13	5	25	73	4	36
14	6	37	14	4	22	74	6	57
15	6½	44	15	4	24	75	1½	20
16	3½	29	16	3½	23	76	3	20
17	4	29	17	4½	28	77	5½	41
18	3	25	18	6	33	78	7	51
19	4	35	19	3	25	79	2	25
20	3½	24	20	4½	47	80	7	47
21	3	23	21	6½	48	81	5	43
22	3	26	22	5	33	82	5	34
23	3	21	23	3	27	83	5½	45
24	4½	31	24	4½	38	84	3½	26
25	4	25	25	3½	33	85	3	24
26	6	38	26	5½	44	86	1	17
27	4	27	27	10	42	87	7	46
			28	5	34	88	4	21
Total...	127	886	29	7	42	89	5	24
			30	4	37	90	4½	21
Average...	4·7	32·8	31	6	47	91	6	36
			32	7	34	92	4½	27
			33	6½	36	93	4½	29
			34	3	31	94	9	74
			35	3	28	95	6½	39
			36	12½	70	96	4	30
			37	5	49	97	4	29
			38	5½	44	98	4	31
			39	6	44	99	3½	28
			40	4½	23	100	6	37
			41	7½	44	101	4½	31
			42	5½	45	102	6	41
			43	6	33	103	6	40
			44	2½	23			
			45	3	24	Total ...	500½	3,553
			46	8	47			
			47	5½	26	Average	4·8	34·4
			48	6	42			
			49	4	27			
			50	3	32			
			51	8	38			
			52	4	17			
			53	5½	57			
			54	5	41			
			55	6	38			
			56	2	20			
			57	6½	51			
			58	7	43			
			59	4	31			
			60	3	33			
			Carried over	303½	2,040			